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SINGLE RAIL RAILWAYS—THE BEHR SYSTEM.

THE main feature of the Brussels International Exhibition, now in progress, is the Behr monorail railway, on which Mr. Behr is said to have expended $150,000, and by which he expects to demonstrate that the system is the one best adapted to maximum speeds. For our illustrations and the accompanying details we are indebted to Engineering.

There is, of course, nothing new in the idea of a single rail railway. Long before Lartigue's time it had been put in ineffectual practice. As long ago as 1826 the notion found favor, was tried and abandoned, to be taken up again and again uselessly. Of late years the most elaborate experiment was the Meigs elevated single line railroad, built at Boston, and tested to absolute discredit. There have been but two systems, of modest application but of undoubted value, on these lines of invention. These were the Lartigue monorail railway and the Caillet system.

Charles Lartigue's invention was an admirable one for its special purpose. He was the engineer to a French company in the large agricultural interests in Algeria. Decauville lines were laid down over the company's estates, but they proved a failure, on account of sand storms that buried the permanent way, obliterating the track often in a few hours. On this account Charles Lartigue built his lines on trestle work, with a single rail, and made his wagons pannierwise; by this means he surmounted the difficulty of the sand storms, and was able to haul his crops without interruption, by mules. With the hopefulness of the inventor, he believed that what was well adapted for an Algerian desert should find a wider application, and he exhibited his elevated railway with a modified construction at an exhibition held at Rouen, about 1883. Again, it appeared in Paris, in 1884, at an agricultural show, for M. Lartigue's ideas of the usefulness of his system did not appear to go farther than its application to agricultural purposes. The line at the Paris show was only a few hundred yards in length, but it was an exhibit of special interest, for the train of cars was propelled by electricity, the current and motors having been furnished by Messrs. Siemens. It was the prototype of the present experiment at Brussels, but it found no practical adoption.

During the following year Mr. F. B. Behr, of 6 Old Jewry, became interested in the Lartigue railway, and sought a wider field for its application. He built the experimental line at Westminster in 1866, and did not convince the public, nor possibly himself, that the system could be profitably applied to ordinary railways. Still, his experiment led to practical results. In 1888 he completed a passenger and freight line from Listowel to Ballybunion, a distance of 10 miles; and this line is still in profitable operation, though, of course, on a small scale, with light traffic, except during the tourist season, when it is busy enough. In France there is another railway—a state railway—about 12 miles long, from Feurs to Pannissères, a minor branch of the Paris-Lyons-and-Mediterranean Railway. In other parts of the world—in Russia, in Trinidad, Guatemala, and elsewhere in South America—there are some 15 or 20 of these lines in successful working, none of important length, and nearly all used for hauling ore, the system being found well adapted for this purpose, where difficult localities involving sharp curves render the use of aerial railways impracticable. At a Spanish mine in the Pyrenees one of these railways is worked electrically.

None of these insignificant applications of the system has anything in common with the latest development, and until now it has never been pretended that the monorail system could secure higher speed, greater safety, and more comfort to passengers than the ordinary railway. But the history we have so briefly sketched is interesting, as linking together the little sand-swept tramway in Algeria with the bold experiment of Mr. Behr at Tervuren.

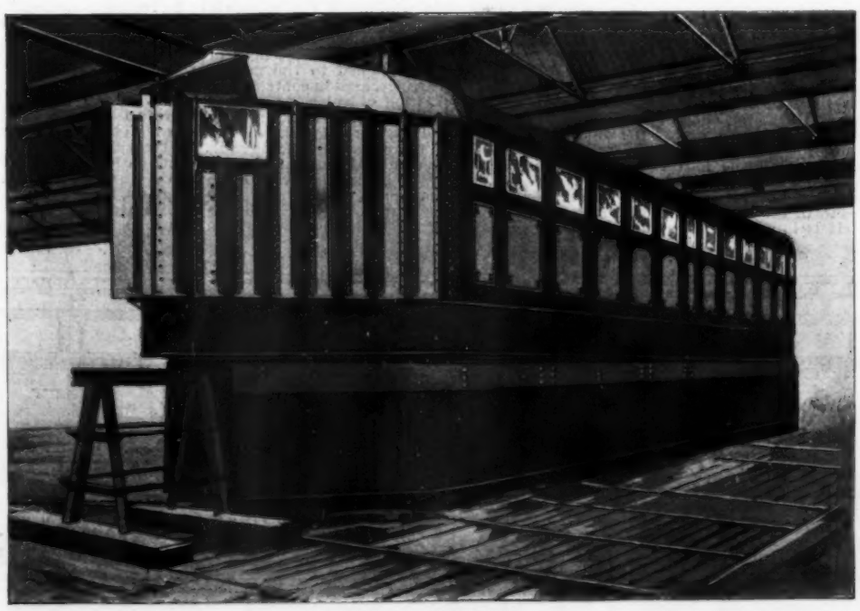
THE BEHR SINGLE RAIL RAILWAY—INTERIOR OF CAR.

The monorail exhibit consists of three parts, not counting the various objects shown to illustrate the early history of the system. These are the permanent way, the carriage, and the power station. The length of the line is about three miles, and consists of two parallel straight portions connected by curves at each end of about 1,600 ft. radius; these arcs of circles are joined to the straight lengths by transition curves. The line is not level throughout, one-half the distance, including a part of the curves, being laid with a grade of 1 in 100. The great ring fence inclosing this ellipse does not lie within the limits of the Tervuren Park, but extends from one end of it, so that the entrance to the exhibit is situated on the boundary of the park.

While Mr. Behr limits his estimate of speed to something less than one hundred miles an hour, he will conduct a series of experiments to ascertain the maximum rate attainable. It may be added that his experiment is being watched with much interest by the Belgian Corps des Ponts et Chaussées, and a report by state engineers will be prepared at the end of the exhibition.

The railway being continuous, and there being only one vehicle placed on it, there is no need for sidings, or for any switches or their equivalent, but devices for effecting junctions form a subsidiary part of the exhibit. The carrying rail is placed on the top of a triangular trestlework of steel, strongly braced in all directions, and resting on steel crossbearers laid in the ballast. Besides the single top rail, there are attached on each side of the trestlework two rails of a special section, and laid flat with the heads outward. These serve as guide rails, on which several series of small inclined wheels mounted on the carriage take a variable bearing as the train is in motion. The triangular members of the trestle are about 4 ft. high, the distance from the top of the sleeper to the bearing surface of the rail being 1·250 meters. The standards are placed at distances of 1 meter (39 in.) apart, except at rail joints, where the distance is made one-half. The carrying rail is of ordinary section, and 82 lb. to the yard. The conductor is attached to the sleepers, and is supported on insulators secured to the sleeper by stud bolts, the conductor rail being held by two screws provided with spring washers. Copper strips form the connections between the conductor lengths.

The carriage is provided with pointed ends to diminish the air resistance, and the inclined faces forming the ends are fitted with adjustable vertical louver plates which can be opened with the view of utilizing them as air brakes. The compartments inclosed within these pointed ends are occupied by the driver and conductor of the car respectively. The vehicle has a sitting capacity for one hundred passengers, arranged in four rows, two on each side of the carrying rail. There are two electric motors to each track, making four in all. These are placed in the lower part of the carriage body below the seats. The bottom of the car extends to within a few inches of the sleepers, and is incased throughout. Within this space is a large amount of mechanism, including the sets of lateral wheels that bear against the side guiding rails. The two trucks, of four wheels each, running on the main rail, are within the recess formed by the framing of the seats. The weight of the carriage in running order is about fifty-five tons. The vehicle is 58 ft. long and about 11 ft. wide. It is framed entirely of steel. Its bottom edge is 7 in. clear of the sleepers, and the floor level is about 5 ft. above, the height of the bearing rail from the sleepers being 4 ft. 1½ in. From the floor or upper deck of the carriage the sides rise so as to give a lofty inclosure for the passengers, and the roof is arched. The carriage is made with a deep recess running for its whole length to receive the wheels and trucks on which it is carried. The driving and guiding mechanism is contained in the hold of the carriage, the electric motors being attached to the framing of the lower deck. Internally the carriage is divided into compartments, one of which, 20 ft. long by 5 ft. 6 in. wide, being reserved for the use of royalty. No expense has been spared in the luxurious internal fittings of the compartments, which are upholstered in Utrecht velvet, the joiner's work being



THE BEHR SINGLE RAIL RAILWAY—EXTERIOR OF CAR.

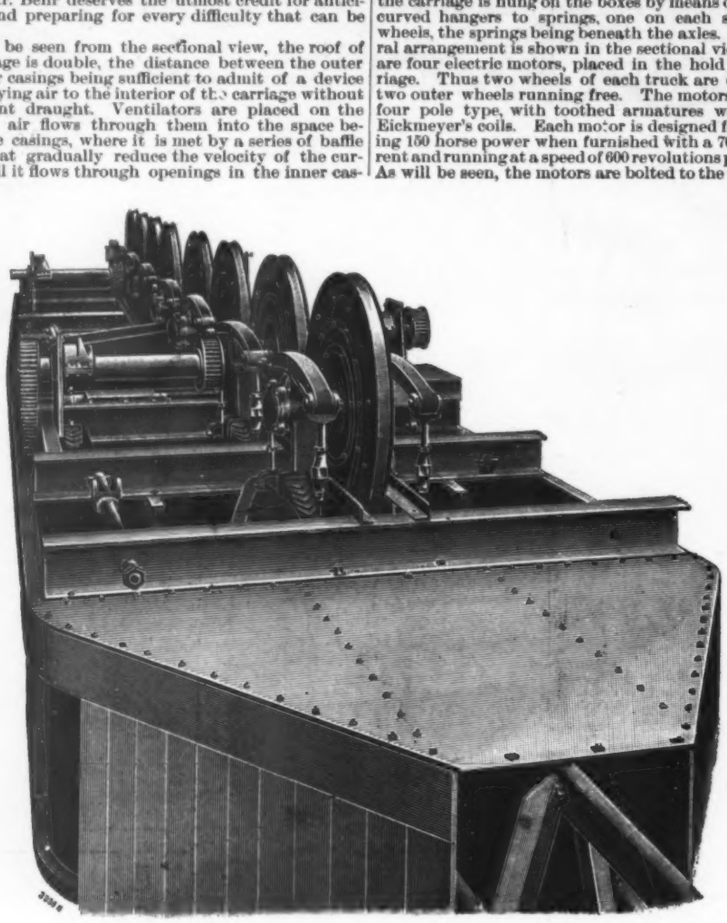
in Spanish mahogany, and the roof linings of imitation leather. The weight of the carriage is about fifty-five tons, which is considerably in excess of the designer's intention, the weight originally proposed having been forty-seven tons. There is evidence throughout the whole structure of remarkable skill and ingenuity in providing against the many unknown conditions that will be met with when running at the velocities intended, and whatever may be the result finally attained, Mr. Behr deserves the utmost credit for anticipating and preparing for every difficulty that can be foreseen.

As will be seen from the sectional view, the roof of the carriage is double, the distance between the outer and inner casings being sufficient to admit of a device for supplying air to the interior of the carriage without any violent draught. Ventilators are placed on the roof, and air flows through them into the space between the casings, where it is met by a series of baffle plates, that gradually reduce the velocity of the current, until it flows through openings in the inner casing, at a convenient rate. As will be seen from the longitudinal section, the carriage is lighted by incandescent lamps, taking their current from the main circuit. The triangular chamber in the bow of the carriage is reserved for the driver, who has at his command various devices for controlling the current, manipulating the special air brakes, and putting on the hand brakes for bringing the carriage to rest. The switch gear is very complicated, and would doubtless be capable of much simplification. Its functions are to couple the motors, two in series when starting, and afterward two in parallel, and for shunting the magnetic fields so as to obtain the maximum speed. Resistances are inserted in series with the motors when first switching on and also when they are first thrown into parallel. The switchboard, as well as the motors, was designed and made by Messrs. Thomas Parker, Limited, of Wolverhampton. One of the original features of the Behr carriage is the arrangement adopted for checking the carriage when running at a higher speed than could be controlled by existing forms of brakes. For this purpose the tapering ends forming the bow of the carriage are fitted for their whole height with a series of louver plates turning on vertical spindles, the lower ends of which are extended beneath the floor and carry worm-wheels that gear into a series of worms on a horizontal shaft. By operating the handwheel all the louver boards on each side of the bow are opened more or less at the will of the driver, and air resistances are created by the exposure of the inner sides of the louvers and the side plates of the frame. It is intended that as soon as the speed is reduced to convenient limits by this means, the stop should be completed by means of the hand brakes, which can be applied to each wheel of the carriage.

The carriage is supported by eight wheels, 4 ft. 6 in. diameter, mounted in two four-wheeled trucks which are coupled at the center by means of a universal joint. The very short axles of the wheels run in boxes mounted on pedestals that are riveted to the main frame, and the carriage is hung on the boxes by means of cast-steel curved hangers to springs, one on each side of the wheels, the springs being beneath the axles. The general arrangement is shown in the sectional view. There are four electric motors, placed in the hold of the carriage. Thus two wheels of each truck are driven, the two outer wheels running free. The motors are of the four pole type, with toothed armatures wound with Eickmeyer's coils. Each motor is designed for developing 150 horse power when furnished with a 700 volt current and running at a speed of 600 revolutions per minute. As will be seen, the motors are bolted to the lower deck of the carriage, and a rigid distance piece connects the motor shaft with the axle of the driven wheel, the speeds of each being equal. The means of transmission is a Renold steel chain, which appears to have given satisfactory results when tested at the Gloucester works. As already explained, the motors are controlled by a switchboard placed in the driver's compartment. When the carriage is started, the four motors are connected in "two-parallel-two series" with a resistance in series between them. This resistance is gradually removed, and the connections are then shifted, until all of the four motors are connected in parallel with the resistances in series. This resistance is then cut out, and the motors in parallel are connected directly across the full electromotive force. If a higher speed is desired than is obtainable by the normal mode of working, the series field winding of the motors is shunted through the resistances. The current for the motor is taken from a conducting rail laid on the sleepers with insulators interposed for the whole length of the track. The current is supplied to the motors through collectors on the carriage, kept in contact with the conductors, and the position of which is shown in the sectional view. The return circuit is made through the wheels of the trucks and the carrying rail.

Besides this carrying rail there are four guiding rails, two on each side of the iron standards, forming part of the permanent way. Working in contact with these rails are sixteen pairs of small guide wheels; there are thus sixteen of these wheels kept in contact with the upper guide rails, and sixteen with the lower. The wheels are 18 in. in diameter. Slots are cut in the steel plating of the carriage adjoining the rails for the wheels to pass through and make contact with the guide rails. The shafts are mounted at the ends of an adjustable frame, shown in the sectional view, and secured to the main frame of the carriage in such a way as to maintain the wheels in contact with the guide rails. The principal work that will be thrown on this device will be in passing round the sharp curves which are characteristic of the Tervuren experimental line.

The electric station which is to supply current for the Behr carriage is being furnished by the exhibition authorities, but unfortunately it is still far from being complete. Indeed, although we believe that at the present time about one-fourth of the ultimate power is available, some time must still elapse before the full energy will be available.



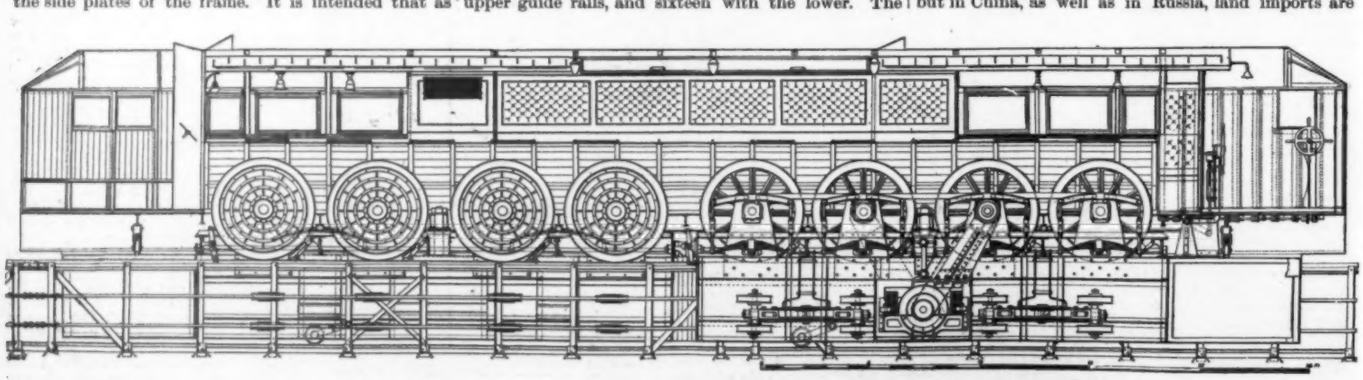
THE BEHR SINGLE RAIL RAILWAY—BOGIE TRUCK.

THE MANCHURIAN RAILWAY.

THE Times correspondent, writing from St. Petersburg, February 5, says: A commission of engineers now holding sittings here for the purpose of discussing technical questions concerning the construction of the Manchurian railway under the presidency of the chief engineer, M. Yugovitch, will leave St. Petersburg for Manchuria about the middle of March. The rest of the year will be spent in completing surveys. There will be considerable work in tunneling at both ends of the line, especially on the eastern section toward its junction with the Ussuri branch of the Siberian railway. Although the articles of association fix next August as the latest time for beginning work, the actual construction of the line is not likely to be commenced before 1898. The Eastern Chinese Railway Company are contracting for about 15,000 tons of rails annually during six years, and will probably order several steamboats and a large number of barges for the river Sungari. The increased number of boats belonging to the two Amur steamship companies are still unable to cope with all the demands created by the new situation. The Sungari, if not too shallow for heavy goods, would be the best channel for transporting railway material from the Amur on to the route of the line through Manchuria. If possible, the Manchurian line will be begun at both ends, but unless the Sungari can be used as suggested, there will be some difficulty in getting the necessary material on to the spot, especially as the Transbaikal section of the Siberian Railway, of which the Manchurian line will be a continuation eastward, will not be completed for some time to come. It will be easier probably to transport the rails and begin from the eastern end at Nikolsk. A sufficient number of native laborers, it is expected, will be found in the country at very cheap rates. In all probability the surveying and working parties will be escorted by Cossacks. In fact, travelers from Siberia report that Cossacks have already been seen in the frontier settlements on Chinese territory. The company, however, say they will have no need of Cossacks unless their rights and property are seriously endangered, and the police force which they are now taking steps to enroll prove unequal to the occasion.

Other travelers' stories bear upon some kind of projected railway from Kiakhta, which would be far more important and profitable for strategical and commercial reasons, but we may assume that the Russians will have enough to do for the present with the line they have already undertaken to build. There is certainly an idea entertained on the Chinese side of effecting a junction between the Chinese railway running to the Manchurian border near the Gulf of Pe-chi-li and the Russian line from Siberia. It must be borne in mind that no one has yet seen the text of the contract made between the Chinese government and the Russo-Chinese bank, which may or may not contain more than has been only incidentally disclosed by publication of the charter granted by the Russian government to the railway company formed by that bank. Whether or not that contract was a tripartite agreement in which the Russian government also took part, as some persons are inclined to believe, there is no doubt that the disclosure of so much of its contents as appeared necessary was calculated to discredit the alleged treaty between the two governments, and the latter as published in the English press is now commonly regarded here as the draft of a compact solicited but never really concluded.

In regard to a remark some time ago in the Times as to the reduction of duties made by China for the benefit of Russian importers via the Manchurian Railway, it is pointed out that it is a mistake to suppose that the favored nation clause will entitle other nations to claim a similar privilege. This advantage is given by China to the Chinese Eastern Railway Company—a private association—and not to the Russian government. The reduced duties, besides entire exemption for transit goods, are simply for overland imports, and other nations may enjoy the same if they place themselves toward China in similar circumstances. If England, we may suppose, made a railway into China from Burma, she might demand the same reductions; but in China, as well as in Russia, land imports are



THE BEHR SINGLE RAIL RAILWAY—SECTIONAL VIEW OF CAR.

taxed differently from those received at the seaports, where all nations in this respect are treated alike. For example, tea imported into Russia overland through Kiakhta is charged with 25 per cent. less duty than tea entering Russia by sea. There is even a differential tariff for the importation of seaborne coal, which is much higher at St. Petersburg and the Baltic ports than at those of the Black Sea. It is not a government that is favored by a reduction of duties on goods introduced by means of the Manchurian Railway, but a private company. The privilege was granted in the concession in lieu of a subsidy to help to make the line a profitable undertaking. The Russian vice president, M. Kerbets, one of the ablest railway men in Russia, will consider himself in the service of the Chinese government, like Sir Robert Hart at the head of the Chinese customs. I may add, in conclusion, that M. Kerbets is also chief director and manager of the Vladikavkaz Railway Company, which is now extending its line from Petrovsk along the coast of the Caspian through Derbend to Baku, and will shortly begin another most important and difficult railway across the mountains of the Caucasus from Kuban district to a point on the Black Sea coast near Sukhum Kaleh, thence to a junction with the railway of the Transcaucasus from Batum. When these two railways are completed the Transcaucasus will be directly connected with the main Russian system at both ends of the great mountain range abutting on the Black Sea and the Caspian.

HURDY-GURDY OR TANGENTIAL WATER WHEELS.

By PHILIP R. BJORLING, in the Colliery Guardian.

TANGENTIAL water wheels, like the Poncelet water wheel, in some respects resemble turbines, but they are simpler in construction, less liable to choke or get out of order, and can be worked by much greater height of fall than any turbine yet designed. They may be termed tangential reaction water wheels, the power being derived primarily from the pressure due to the head of water supplied by a pipe discharging upon the wheel buckets by a nozzle, the size of which is proportional to the amount of water available and head and power required. Some makers of these wheels guarantee 80 per cent. effective duty out of the power due to the height of fall, and some even claim that as high as 88 per cent. has been obtained. The original bucket consisted of flat plates, but it was afterward found better to receive the stream on a strip edge, so as to divide it, and terminate the sides of the bucket by a curve, so as to reverse the current of water. The principal difference in these water wheels constructed by the various makers consists in the shape and position of the buckets, and in the manner in which they are regulated.

The Dodd "signoidal" bucket, illustrated in perspective in Fig. 1, is provided at the center with a midfeather which divides the water jet.

FIG. 1.

Fig. 2 illustrates, also in perspective, Mr. Knight's bucket, in which there is no midfeather, but the inventor claims the advantage that he can apply a larger amount of water with a single nozzle, and can, therefore, use his wheels for low heads.

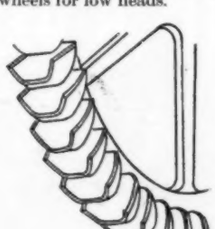


FIG. 2.

The Berry wheel is illustrated in Fig. 3, in which A is the line of the jet meeting the buckets, B, which are secured to the wheel with bolts. The buckets are radial and their convex face presented to the jet; they

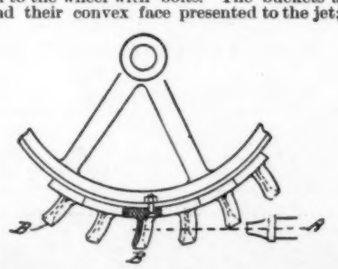


FIG. 3.

are formed with a double curved bottom, presenting a sharp dividing apex in the center which splits the stream of water discharged on the wheel, and also curved in the opposite plane so that they will present a convex surface, normal to the stream of water, in all positions of the buckets.

The wheel which is most extensively used, especially on the Pacific coast, is the Pelton water wheel, one of which, with a single nozzle, is illustrated in elevation (Fig. 4), enlarged sectional elevation of bucket (Fig. 5), and plan of the same (Fig. 6). This wheel is manufactured in this country by Messrs. Frazer and Chalmers. The buckets, A, secured to the periphery of the wheel, B, are of a peculiar shape, and divide the jet of water in such a way as to develop its full power, while in emerging they sweep against the curved sides with a reactionary influence, which has the effect of prolonging the impact. It is also by this means deflected from the wheel so as to offer no resistance to its motion. The

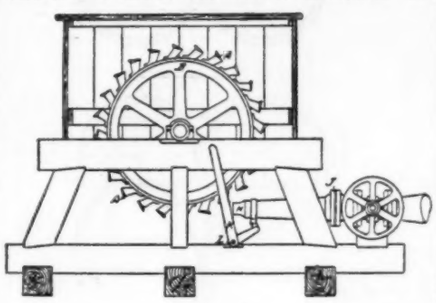


FIG. 4.

power of this class of water wheel does not depend upon the diameter of the wheel, but upon the head and amount of water applied to it. Where a great power is wanted under a comparatively low head, a larger wheel is necessary to admit of buckets of sufficient size to deal with a large stream. Wheels of greater diameter are also desirable in many cases as a means of reducing the speed, even in cases where the smaller wheels would furnish all the power required. For instance, buckets suitable for smaller wheels are frequently fitted on to wheels of larger diameter to reduce the speed; this is particularly the case when light heads are dealt with. The two or three nozzle wheels are only for the purpose of increasing the power by the use of a large amount of water, and the head is so low that a single stream or jet will not give the power required. These wheels have been working successfully with heads varying from 10 to 1,680 ft. One of the great advantages of this class of wheels is the facility with which wide variations of power can be produced without impairing the efficiency. This can be accomplished in three ways, namely:

1. By changing the size of the nozzle tip or tips, and by that means varying the size of jet or jets thrown on

FIG. 5.

the wheel, the power of which can be varied from its maximum capacity down to one-fourth of its power without appreciable loss, thus adapting it to a full supply of water when obtainable, or to a reduced quantity when from any reason the supply is limited.

2. The second method of varying the power is shown in Fig. 4, which illustrates a 6 ft. wheel fitted with deflecting nozzle, H. It is made 3 ft. 5 in. in length, attached to a ball and socket joint, J, and raised and lowered by a bell crank lever, K, working on a fulcrum, L. By this arrangement the whole or any part of the stream can be thrown on or off the wheel instantly, thus affording such variations of speed and power as may be desired to accommodate any change in load or supply of water. The amount of water wasted is so small as in most cases not to be worth consideration.

3. When great steadiness and even running is important, and the head is not sufficient to give the required power with an ordinary wheel of one jet, a wheel of larger diameter, allowing of a larger jet, is to be recommended, instead of using two, as the deflecting nozzle with a governor attached can only be used

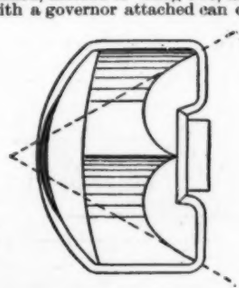


FIG. 6.

with a single nozzle. In such cases the nozzle lever is actuated automatically by a governor.

The peculiar feature of Mr. C. L. Hett's patent hurdy-gurdy wheel consists in an improved regulating nozzle, by means of which the power of the wheel can be changed without raising or lowering the nozzle, thus dispensing with the necessary ball and socket joint, and obviating waste of water.

The arrangement of the nozzle, when the regulation of speed or adjustment is performed by a hand wheel, is illustrated in Fig. 7, in which A is a casting pro-

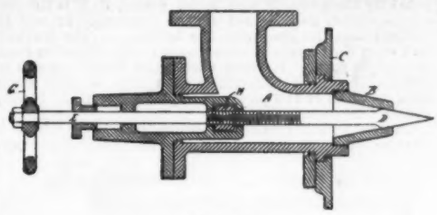


FIG. 7.

vided with the inlet branch, and bolted to the wheel casing, C; B is the nozzle into which is fitted a plug or spear, D, at the end of the screwed spindle, E, the latter working in a gun metal nut, H, and actuated by means of the hand wheel, G. It will be clearly seen that by turning the hand wheel the spear is either pushed into the nozzle, closing it, as shown in the illustration, or opened more or less according to requirements.

Mr. Hett's automatic nozzle is shown in sectional elevation, Fig. 8. It consists of the spear, A, and nozzle, B, as in the previous case, but in this instance the spear is actuated by means of the head of water acting on a piston in a hydraulic cylinder, the admission and discharge of water to and from the cylinder being regulated by a high speed centrifugal governor. In the illustration, C is the hydraulic cylinder and D the piston, the latter being secured to the spear. E is a piston valve, connected to the valve spindle and lever with the governor, H. The governor is driven in the usual way, with a belt from the wheel spindle. J is a passage for admitting water under pressure from the

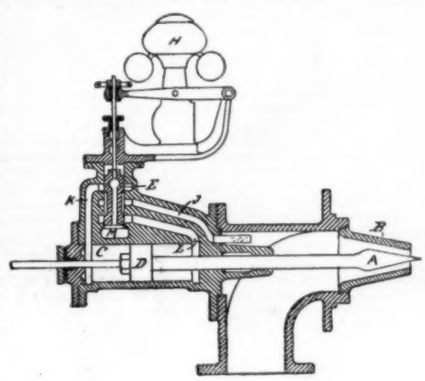


FIG. 8.

main inlet. K and L are ports for admitting and allowing the escape of water to and from the hydraulic cylinder. M is the discharge pipe. The action of this governing apparatus is as follows:

Assume the wheel to be running at its normal speed, the governor holds the valve, E, in midposition, as shown in the illustration, and the piston, D, in the hydraulic cylinder is in equilibrium and stationary. If the speed varies, the governor either rises or falls, moving the valve, which admits water under pressure to one or the other side of the piston, as the case may be, at the same time opening the delivery pipe and allowing water on the opposite side of the piston to escape. The piston and spear move and admit or cut off water to the wheel until the normal speed is again obtained. Two or more wheels may be used on the same shaft, where the head of water is low, to admit of getting the power desired from one wheel.

In Cadle's patent duplex hurdy-gurdy water wheel

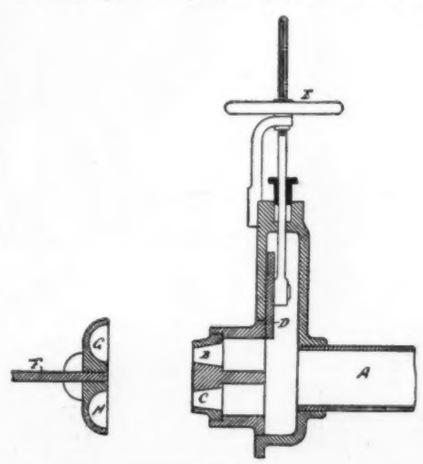


FIG. 9.

the buckets fit on the disk of the wheel into recesses, which are cast there to receive them. They are held in position by a single bolt passing through opposite buckets. No strain due to the impact of the water

comes upon the bolts; they simply serve to hold the buckets in their places, all the strain being taken by the lugs and ribs upon the disk into which the buckets fit.

Fig. 9 is a sectional elevation through the sluice, nozzles and buckets of one of the Cadle water wheels. A is the main pressure pipe; B and C the nozzles, regulated by the slide, D, and hand wheel, E; F is the rim of the wheel, and G and H the buckets. It will be noticed that the jets strike the bottom of the bucket, and turn the stream of water back to the direction from whence it came. In this wheel the slide is made to open one side of the nozzle at a time, so that when only one-half of the power is required the slide is only drawn half open.

Cadle's patent quadruple tangential water wheel is illustrated in sectional elevation Fig. 10. In this there

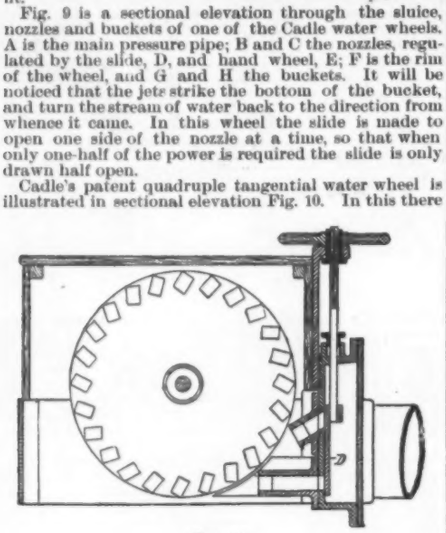


FIG. 10.

are two pairs of double nozzles, one pair above the other. The same slide, D, controls all the nozzles, it being so proportioned that when it is opened it first uncovers the lower nozzles, and a further movement opens the upper pair. By this arrangement the power of the wheel is doubled, and when only half power is required only the lower nozzles are opened.

The James Leffel cascade water wheel has the water admitted to it by one, two or more nozzles without decreasing the useful effect of the water; but the percentage remains the same, whether one or more be used. Each nozzle increases the power in the direct proportion of the increase of their number, requiring a proportional increase in the quantity of water. The peculiarity of the construction of this wheel is that the buckets are arranged alternately on each side of a central, sharp, continuous dividing ridge, projecting a little in front of the entering edge of the bucket. The dividing ridge has a sharp cutting edge, which serves to divide the jet of water before it reaches the buckets, and to keep it continuously divided into equal portions, so that each portion of this single jet is received separately on each side of the dividing ridge. Each series of buckets is so arranged that they catch the water alternately. It is claimed for this wheel that the alternate arrangement of buckets secures greater steadiness of motion, as it is equivalent to twice the number of buckets, and the forces are therefore distributed more regularly on the wheel.

The latest, and to all appearance the best, hurdy-gurdy or impulse water wheel is the one patented by Mr. F. M. F. Cazin, of New York, and manufactured by the American Impulse Wheel Company. This wheel is illustrated in Fig. 11. The slide, A, is so arranged

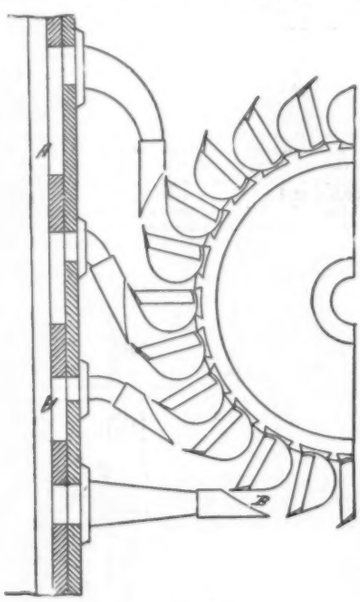


FIG. 11.

that one, two, three, or four nozzles can be used as required. Fig. 12 is a front view of a pair of buckets; Fig. 13 a plan, and Fig. 14 a cross section. The buckets are secured in their places on the rim of the wheel by means of a dovetail and bolts. The jet in an impulse wheel loses some of its maximum efficiency by the weight of the water being carried for some distance without support before striking the wheel, so that in this respect it is inferior to the turbine. In the Cazin wheel the nozzle mouth is shaped closely by and to the extreme circle in which the bucket revolves, as shown at B. It will be noticed that the bucket is curved every way, so as to perfectly reverse the current in every direction, and there is a lip which guides the jets into the bucket presented to it, and directly that is passed, into the next bucket. The diameter of jet is, as a rule, equal to the radius of the bucket cavity, which gives to half the jet four times its original width of space in which it may turn in its own course. For economical reasons the jets are made two-thirds of the

FIG. 12.

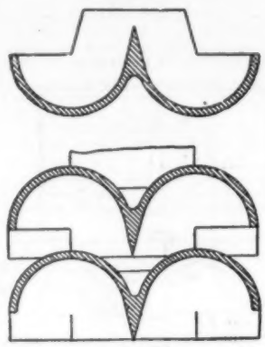


FIG. 13

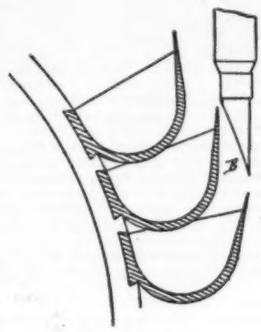


FIG. 14.

diameter of the bucket centers, as their diameter may be applied, which gives to the jet halves three times their width as space to inverse their direction of motion.

THE COEFFICIENT OF TRACTION OF CARRIAGES.

THE rapid progress of automobile locomotion has made the question of the coefficient of traction of the different tires used on the wheels of vehicles the order of the day. Opinions are as yet much divided, and it requires nothing less than direct and accurate experiments to solve the problem definitely and to show, without possible dispute in the future, the superiority of the pneumatic tire over that of iron and solid rubber.

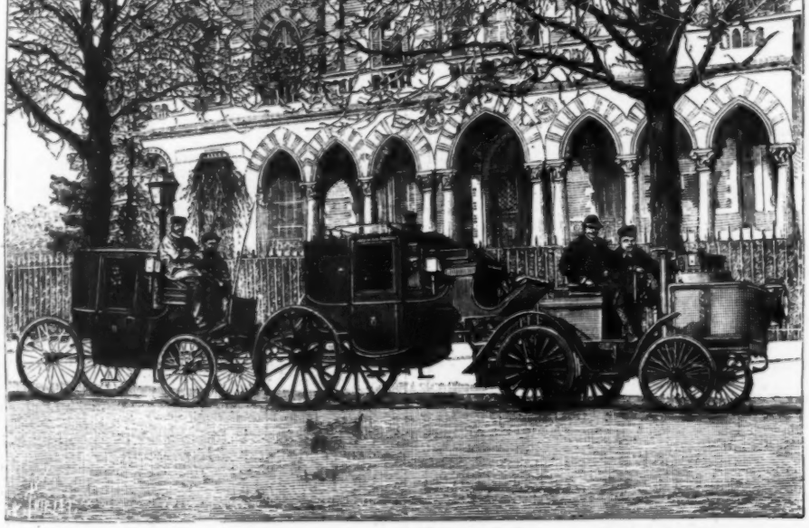
Some convincing experiments were made last year by M. Michelin, but the figures obtained were merely comparative and did not furnish numerical results capable of serving for the calculation of the power of motors to be placed upon horseless vehicles. The experiments have been recently resumed under more favorable conditions in the vicinity of Paris, by means of the singular train shown in Fig. 1. But, before describing the apparatus, a word as to the definition of the factors to be measured. As well known, in order that a vehicle may be hauled upon a road, which, in order to simplify the problem, we may suppose to be level, it is necessary that there shall be exerted a certain stress—a horizontal force, that depends upon the nature of the road, the weight of the vehicle, the nature of the tires and the suspension, rolling and speed of the vehicle. Such tractive force is measured in kilogrammes, and the ratio of such force in kilogrammes to the weight of the carriage hauled (likewise measured in kilogrammes) constitutes the coefficient of traction, which is generally expressed in kilogrammes per ton, or, more simply, in thousandths, with a view to avoiding the use of fractional numbers.

The experimental problem, therefore, consists in causing a carriage of known weight, whose wheels are provided with the tires to be studied, to be hauled over roads of varied character and in measuring the tractive stress exerted at every moment. From this is deduced the coefficient of traction by the simple calculation just mentioned.

In the experiments made by M. Fonvielle, under the direction of M. Michelin, a De Dion steam locomotive hauled the carriage through the intermedium of a registering dynamometer installed in a coach placed between the locomotive and the carriage hauled (Fig. 1).

The dynamometric coach belongs to the Compagnie Générale des Voitures. The dynamometer consists, in principle, of a double spring arranged transversely in the carriage. The middle of one of the bands is fixed to the carriage, and the middle of the other is attached directly to the vehicle to be hauled through an iron bar that traverses the coach. Under the tractive stress, the spring bends, opens, and leaves its position of equilibrium by a length proportional to the stress exerted.

If a pencil be placed vertically upon the movable part of the spring, and a band of paper be made to unwind transversely and with a uniform motion under the point of the pencil, the latter will trace a curve that will permit of determining the amount of the



Carriage under experiment. Dynamometric carriage. Locomotive.

FIG. 1.—DYNAMOMETRIC TRAIN USED IN DETERMINING THE COEFFICIENT OF TRACTION OF CARRIAGES.

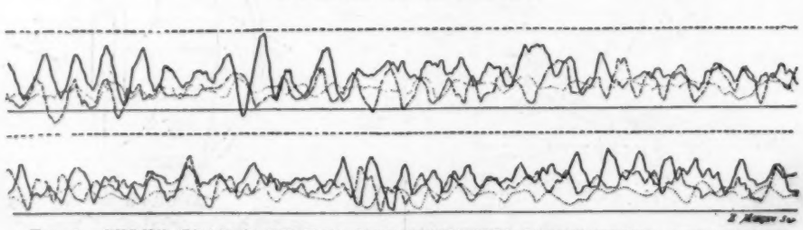


FIG. 2.—CURVE TRACED BY THE DYNAMOMETRIC REGISTERING APPARATUS UPON THE QUAI PRESIDENT CARNOT ROAD.

——, iron tires; — — —, solid rubber tires; ....., pneumatic tires.

stress at every instant, as well as the mean value of such stress upon a given length of roadway.

In order to determine the speed, another pencil bears against the paper continuously and is lifted for an instant, at every revolution of the wheel, through a mechanism actuated by the latter. It thus traces an interrupted line that permits of measuring the speed of the vehicle deduced from that of the unwinding of the paper, from the number of interruptions and from the length of the circumference of the wheel controlling the pencil.

The diagram in Fig. 2 shows the traces obtained with different tires (solid rubber, pneumatic and iron) at a speed of 22 kilometers (13 miles) an hour upon the old, dry and somewhat broken up macadamized Quai President Carnot road, at Suresnes. The experiments were made in replacing the wheels of the carriage and in equalizing their weight. It will be remarked that the curves relative to the pneumatic tires are not so high as and much more regular than those that correspond to the iron ones. The tractive stress is, therefore, more regular, and the shocks less perceptible with the pneumatic than with the solid rubber tire.

The mean values of the coefficients of traction deduced from these experiments, in integrating the results obtained upon runs of 1 kilometer (0·6 of a mile) are summed up in the following table:

CONDITIONS OF THE EXPERIMENT.

	Tires.		
	Iron.	Solid Rubber.	Pneumatic.
I. Boulevard de la Seine: (Level.)			
Good macadam, hard, dry and dusty.			
Wind ahead, v = 11·7 km. per hour	27·3	34·5	22·3
Wind behind, v = 11·7 " "	25 3	22·8	20 8
Wind ahead, v = 19·7 " "	34·4	29·9	24·8
Wind behind, v = 19·7 " "	27·6	25·2	23·8
Good macadam, hard and slightly muddy.			
v = 11 km. per hour	27·4	26 5	24 0
v = 20 " "	30·9	35 6	31 8
Good macadam, water soaked.			
v = 21 km. per hour	45·6	42 6	35·0
II. Boulevard de Versailles: (Grade of 40-1000.)			
Good macadam, hard, dry and dusty.			
v = 11 km. per hour	62·1	61·1	57·2
v = 19 " "	73 0	64·1	59·6
III. Route of St. Germain: (Grade of 5-1000.)			
Ordinary pavement, slightly rough and dry.			
v = 11 km. per hour	42·2	40·1	36·1
Ordinary pavement, slightly rough and with sticky mud.			
v = 18 km. per hour	54·9	57·6	44·0
Ordinary pavement, slightly rough and with half dry mud.			
v = 12·5 km. per hour	44 5	41·6	36·0
v = 20 " "	52·2	56·0	40·7
IV. Quai President Carnot: (Level.)			
Old macadam, somewhat broken up.			
v = 22 km. per hour	33·8	28·0	22·5

These figures bring clearly into relief the influence of speed as well as that of the wind upon the coefficient of traction. The superiority of the pneumatic over the iron tire, which is only 10 per cent. at a feeble speed and upon a good road, rises to 33 per cent. when the road is broken up and the speed reaches 22 kilometers an hour.

It may be said, without exaggeration, that the use of the pneumatic tire permits of a gain of from 20 to 25 per cent., on an average, upon the coefficient of traction, and, consequently, upon the power of the motor and consumption of fuel.

Such advantages are not to be disregarded, and although they have been recognized in principle by all competent specialists, we have to be thankful to M. André Michelin for having fixed the extent of their importance by accurate experiments and by means of registering apparatus of which the impartiality is beyond question.—E. Hospitalier, in La Nature.

SIX N. H. P. TRACTION ENGINE.

WE illustrate below an improved type of traction engine exhibited at the Bath and West and Southern Counties Agricultural Show by Messrs. Ruston, Proctor & Co., Limited, Lincoln, which possesses several novel features worthy of more than passing attention, particularly a single eccentric, reversing gear, illustrations of which are given in Figs. 1, 2, 3, and 4 herewith. The engine shown is particularly adapted for driving plowing tackle, thrashing and other machinery. It has a boiler of comparatively large capacity, the plates of which are of Siemens-Martin mild steel, and intended to withstand a working pressure of 120 pounds per square inch. The horn plates are of steel, riveted to the fire box and to each other, making a rigid frame, while the top of each plate is recessed to receive the

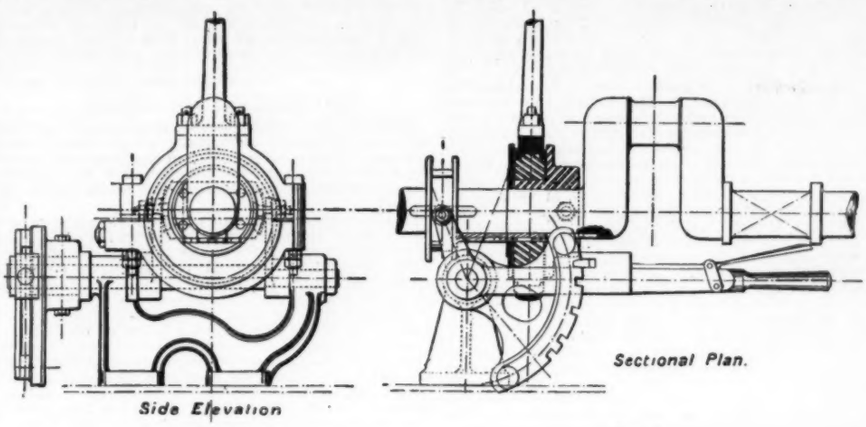


FIG. 1. FIG. 2.

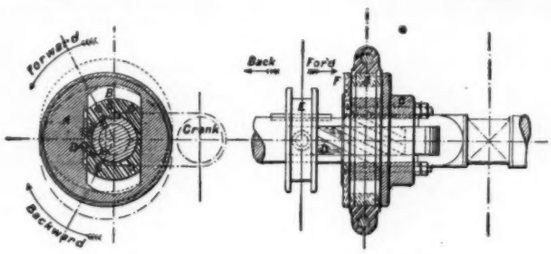
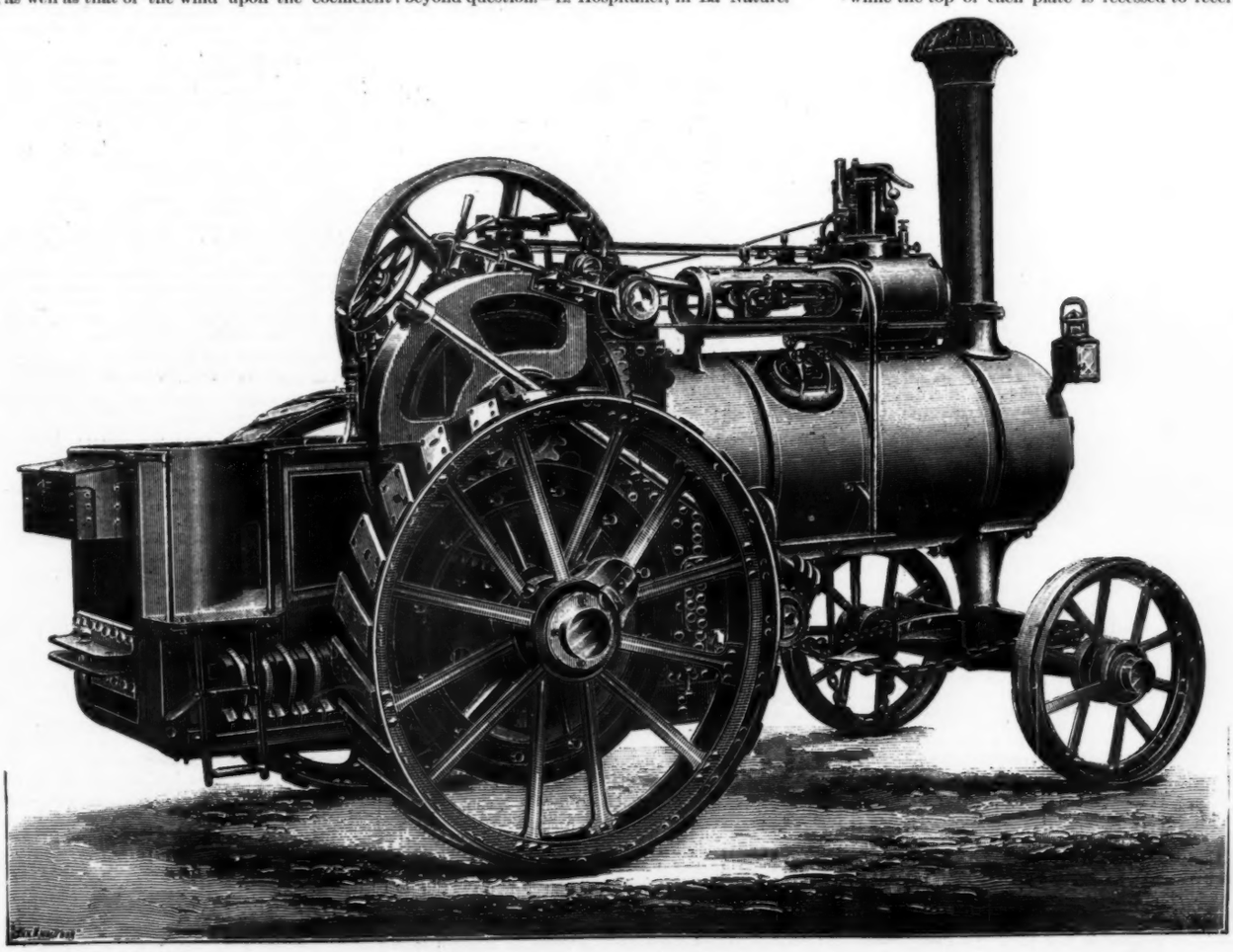


FIG. 3. FIG. 4.



SIX N. H. P. TRACTION ENGINE.

crank shaft pedestals. The main portion of the single eccentric reversing gear consists of two moving pieces only, the eccentric, A—Figs. 3 and 4—which has an elongated slot cut centrally with the crank shaft and at right angles to the crank positions, made to fit and move freely on flats cut upon the boss of the main driving plate, C, and a sliding bar of steel securely fastened to the clutch, E, so that both may be moved easily in either direction parallel to the axis of the crank shaft. Upon the outer face of the bar, D, is formed a series of inclined teeth, which engage with similar spaces and teeth cut on one side of the slot in the eccentric, A. It will be clear that on moving the clutch, E, and bar, D, from side to side along the crank shaft, the eccentric will be made to rise and fall above and below its central position, as shown by the dotted lines in Fig. 3. The clutch, E, is driven by a feather key, upon which it slides freely, so that while it rotates with the crank shaft it can be easily pushed in and out by the clutch dies and reversing levers. The bar, D, in addition to being milled out at the back to fit the radius of the crank shaft, is fitted in a slot in the main driving plate, C, so that it is impossible for any twisting movement to occur which would cause a locking of the gear. A cover plate, F, is provided, and firmly secured by bolts passing through the main driving plate, C, so that the eccentric A, is held freely but firmly by the two plates, F and C, between which it rises and falls. It will be clear that the center of the eccentric is thus moved from the "forward" position, a, perpendicularly down the lap line, a, b, of the Zeuner diagram to b, which is the center of maximum throw for the "backward" motion. The effect of this movement is to vary both the travel and angle of advance of the eccentric. The chief factor in the success of this gear is the fact that while the rotation of the eccentric is easily performed by the large flat surfaces on the driving boss, C, none of the work of driving the valve is thrown upon the bar, D, which is thus free to move the eccentric and hold it in any required position with very little effort on the part of the driver.

We are indebted to The Engineer, of London, for the cuts and description.

HOW CLOTH IS DYED SEVERAL COLORS AT ONCE.

THE following methods of dyeing a piece of goods with several colors simultaneously are now largely used in Europe, according to the Textile World. All the methods are quite simple in theory, depending chiefly on the various absorptive powers of different fibers for different dyes.

There are but few dyes that tinge wool, silk, and cotton equally with the same preparation. The one or the other remains undyed, according to the kind of fiber and method, and may be dyed subsequently with another dye. . . . . The trifling quantity of dye mechanically precipitated upon the dyed fiber must be stripped first, however, but in such a manner that the color lake formed upon the dyed fiber is either not at all or at most very little attacked. A simple boil in condensed water or in a weak bath of acetate of ammonia suffices frequently.

Two-color half woolen weaves are generally produced in such a way that the wool is dyed first; the cotton is then mordanted with tannin and antimony, or antimony salt, and dyed with basic dyes from cold to warm. . . . .

Differences of temperature also influence frequently the fixation of a dye upon one of the fibers, and its indifferent behavior to the other. For instance, the so-called changeable effects upon piece-dyed gloria. These fabrics generally consist of woolen warp and silk filling, and both fibers are dyed in a different color, say the wool red, the silk green; wool garnet, silk blue, etc. The wool is dyed in a boiling bath; . . . the dye adhering to the silk is stripped by treating for thirty minutes with boiling water, and the silk is next dyed in a cold bath.

Still more curious effects can be produced when the different fibers have been treated, before weaving, with different chemicals.

As many mordant dyes furnish different colors according to the mordants used, it will become possible to produce in this way more than two colors. For instance, alizarine red gives a bordeaux upon chrome, a high red upon alum, and lilac upon iron. Consequently, by weaving together yarn treated with these three mordants and dyeing the weave in an alazarine bath, a triple colored weave will be the result, and in case unmordanted yarn was also used, a fabric of four colors will be obtained. Again, the cotton dyer can, with different mordants, produce different shades of the same color. For instance, the tone of many colors dyed upon a sumac differs from that upon tannin-antimony, or antimony. Yarn treated with these two mordants and woven together with unmordanted, next dyed in two baths, gives a triple colored weave.

INDIAN INK MANUFACTURE.

AN interesting account of the manufacture of the so-called Indian ink, which is made only in the Anhui province of China, is given by Mr. Frazer, British consul at Wuku, on the Yang tsze, in his last trade report. It is more correctly called China ink—encre de Chine—and from Anhui it goes to every part of China and all over the world. In 1895 about two tons of it, valued at £564, were exported from Shanghai to foreign countries. The materials with which this beautiful black ink is made are sesamum or colzá oil, or the oil expressed from the poisonous seeds of a tree extensively cultivated in the Yang-tsze valley, and also well known in Japan. To this varnish and pork fat are added. The lampblack made by the combustion of these substances is classed according to the materials and the grade of fineness, and also according to the time taken over the process of combustion. The paste made of this lampblack has some glue added, and is beaten on wooden anvils with steel hammers. Two good hammerers can prepare in a day 80 pieces, each weighing half a pound. A certain quantity of musk of the musk deer or of Baroos camphor, for scenting, and gold leaves, varying from 20 to 100 to the pound, are added to give a metallic luster. The materials thus prepared are moulded in moulds of carved wood, dried, which takes about twenty days in fine weather, and adorned with Chinese characters in gilding. About 30 or 32 average-sized sticks of ink go to the pound. The price varies from 2s. or less per pound to as much as £7, there being over a dozen different grades. Nearly all writing is done by the natives throughout China, Japan, Korea, Tongking and Anam with this China ink, rubbed down on a stone ink slab and applied with a paint brush of sable, fox or rabbit hair, set in a bamboo holder, and, when not in use, carefully covered with a protecting brass cap. The superior kinds of this ink appear to be used in China and not exported.

PHOTOGRAPHY IN COLORS.

PROF. GRABY read a paper on photography in colors before the Académie des Sciences in Paris recently, and not only explained every detail of the process and gave the exact formula to be followed, but also showed some remarkable photographs in colors taken by himself.

In almost all the attempts made previously to reproduce color in photography the processes have depended upon the physical effects of the interference of light. Prof. Graby has depended entirely upon chemical action. His explanation of the process, as described in his paper, says the New York Sun, is as follows:

"When a plate of metallic silver is exposed in the dark to the action of chlorine, a series of chlorides is formed, ranging in color from yellow through red to blue. If the same plate be afterward exposed to light the action is reversed, the final result being yellowish white. If pure white silver chloride dipped in a bath of silver nitrate be subjected to feeble blue light, a blue subchloride will be produced which will retain a large proportion of the original chlorine. Similarly a red subchloride can be obtained, containing still less chlorine. The yellow is secured by a less direct method, for, although a grayish yellow subchloride of silver can be produced, it is not sufficiently pure in color or capable of giving all tints. Consequently chromic acid or a chromate is introduced, giving a golden yellow complementary to the blue violet of the silver, which is degraded by the light, furnishing all the yellows imaginable.

"Under the influence of blue light the blue subchloride is not sensitive, and remains the same, but the red, if mercuric chloride be present, takes up chlorine and is converted into the blue. If chromic acid be present also the yellow becomes oxidized to blue, so that only blue remains.

"Under yellow light the chromic acid is not effective, but the blue and red—especially the former—are bleached, losing their chlorine and amalgamating with mercury.

"Under red light, the red subchloride remains unchanged, but the blue is changed by the red orange rays into red subchloride.

"White light produces blue or greenish yellow, according to whether the paper is exposed in the dry or moist condition.

"To secure permanency, the yellow is fixed by washing the print with acetate of lead, which renders the chromate insoluble. The blue and red are obtained by introducing bichloride of mercury and salt into the coating of the paper. These two substances keep up a state of equilibrium as regards the action of light on the chlorine, so that the blue and red subchlorides retain their composition indefinitely. This fixing can only take place after the white has been fixed, except on salted and albumenized papers, to which, however, the subsequent method of fixing the white cannot be applied. Therefore complete fixation can only be secured with gelatine papers, and this is the most important point of the discovery.

"The trouble found for a long time was that the violet-blue silver compound produced by the action of white light could not be removed without seriously affecting the blue of the print. The first method tried was one in which the white light rendered the gelatine soluble, as in the perchloride of iron process. It was found that the gelatine became less soluble according to the color of the print. White light rendered the gelatine completely soluble, yellow light a little less so, red still a little less soluble and blue almost entirely insoluble. The gelatine in melting removed the chloride, which would have become blue, subsequently to fixation, on exposure to light. Thus, in the first method, the yellow was fixed with acetate of lead, the white by washing with warm water, and the red and blue by salt and bichloride of mercury.

"The first method could only be carried out with paper prepared as follows: Gelatino-chloride paper is allowed to become blue, almost to the violet stage, by immersing it in a bath of

Water	100
Hydrochloric acid	4

and exposing it to diffused light, then dipping it, when dry, into

Water	100
Bichromate of potash	1

"It is dried afresh and exposed anew until all the gelatine is just rendered insoluble. The paper is then ready to be sensitized for colors in the following bath:

Water	4	ounces.
Nitric acid	10	drops.
Mercuric nitrate	1	drachm.
Hydrochloric acid	1½	"
Sulphuric acid	½	"
Chromic acid	45	grains.
Soda alum	90	"

"This paper must be employed wet. The results so obtained are most interesting. But for practical work the paper prepared in the second manner should be used.

"In this method the light renders the gelatine insoluble, as in the carbon process. Gelatino-chloride paper is treated with acid and blued as above, then dipped in a bichromate bath, and then in a nitrate of mercury. When dry, it is printed so as to reproduce the colors. After this it is treated with acetate of lead; then the image is transferred on to another paper and washed, as in the carbon process. Finally it is passed through a bath of bichloride of mercury and salt."

SELECTED FORMULÆ.

Keeping Flies off Stock.—Try one of the following:

(1.) Carbolic acid	1	ounce.
Oil of pennyroyal	2	"
Spirit of camphor	2	"
Oil tar	4	"
Glycerine	2	"
Fish oil	2	"
(2.) Pine tar	1	part.
Fish oil	2	"

The oil is used to keep the tar from sticking; if fish oil cannot be obtained, lard oil may be used. An addition of 2 ounces of crude carbolic acid to the gallon of paste will improve it. Paint the mixture on when necessary.

(3.) Black oil	1	quart.
Crude carbolic acid	4	ounces.
Fish oil, enough to make	1	gallon.

—Pharmaceutical Era.

Preservative for Eggs.—Various preparations for preserving eggs for winter use are sold to unsophisticated housewives, and usually at a good profit for the manufacturer. The principle upon which most of such compounds act is that of excluding the air; almost any wax or varnish will serve this purpose. There are two requisites—have the eggs fresh and clean and put them up as late in the season as possible.

One very ancient and universally applied method consists in dipping the eggs into melted wax or paraffin. We append a formula for preparing a coating solution which duplicates one very extensively sold:

Gelatine	½ ounce.
Borax	⅛ "
Water to make	10 "

Dissolve gelatine in the hot water in which the borax has been previously dissolved; bottle. If too stiff, warm the solution; rub on the eggs, or dip the eggs in the solution.—Bulletin of Pharmacy.

How to Make Potpourri.—The never failing delight of a rose (or potpourri) jar is known only to its fortunate possessor; yet it is so easy to prepare one, and, once prepared, so easy to keep it at the point of perfection, that the wonder is they are not more frequently enjoyed. The flowers should be gathered in the early morning, and tossed lightly on a table in a cool, airy place, to lie till the dew has evaporated; then put them in a large glass jar, sprinkling salt over ¼ in. layers of the flowers. This can be added to from morning to morning till enough flowers for the purpose have been gathered, letting them stand in the jar for ten days after the last are put in, stirring the whole every morning. Have 1 oz. each of cloves and allspice, coarsely ground, and as much stick cinnamon, broken and shredded fine; transfer the flowers to another jar, and scatter the spices, mixed together, in layers; cover the jar tightly, and let it stand in a dark place for three weeks, when the stock will be ready for the permanent jar. Whatever this jar is, be sure it is provided with a double cover.

Have ready ¼ oz. of mace and ½ oz. of allspice and cloves, all coarsely ground—or pounded in a mortar—half of a grated nutmeg, ½ oz. of cinnamon, broken in bits, 1 oz. of powdered orris root, and ¼ lb. of dried lavender flowers. Mix these together in a bowl, and proceed to fill the rose jar with alternate layers of the "stock" and the mixture of spices, etc. A few drops each of several essential oils—rose, geranium, bitter almond and orange flower are good—should be dropped upon the layers as you progress, and over the whole pour 1 oz. of your favorite toilet water or eau de cologne. This is sufficient to fill two quart jars, or one very large one, and it will keep for years; from time to time various sweet things may be added to it, as a few tuberoses or a spray of heliotrope. If the jar be left open for a half hour every day, it will fill your rooms with a delicate, indefinable spicy fragrance, very refreshing and delightful, and unlike any other perfume. The flowers chosen should be those having agreeable perfume, roses, pinks, violets, verbena, heliotrope, acacia, balm, lavender, etc.

Photographic Hints and Formulas.—

From Liesegang's Photographischer Almanach.—(Amer. Photo. Jl.)

Toning Bath (sulphocyanate of ammonium).—Two solutions are to be prepared:

(a.) Water	1	liter.
Sulphocyanate of ammonium	30	grms.
Hyposulphite of soda	5	"
(b.) Water	200	c. cm.
Chloride of gold	1	grm.

For use, pour 40 c. cm. of (b) into 200 c. cm. of (a). If in reversed order, the bath will be precipitated.

Combined Toning and Fixing Bath.—

Water	1	liter.
Hypo	175	grms.
Alum	20	"
Sulphocyanate of ammonium	10	"
Common salt	40	"

After a short time this solution becomes turbid; it is then to be left to settle for eight days, then decanted and filtered, then add:

Water	100	c. cm.
Chloride of gold	1	grm.

Mountant for Silver Prints.—

Gelatine	100 grms.

Swell in cold water, the superfluous water is then poured off and the gelatine dissolved by aid of a gentle heat. Then add with constant stirring:

Water	50	c. cm.
Alcohol	150	"
Glycerine	50	"
Carbolic acid	20	drops.

This permanent non-cockling mountant thickens in the cold. For use, the bottle or jar is to be placed in warm water, which liquefies the mass; it is then ready for use.

ENGINEERING NOTES.

Germany's highest bridge is over the Wupperthal, at Mungsten, near Remscheid, back of Elberfeld. It is 360 ft. high and 1,630 ft. long, the central arch having a span of 530 ft. The only higher bridge in Europe is the Garabit viaduct, 405 ft. high, in southern France. The Mungsten bridge was opened for railway traffic on July 1.

A new experimental locomotive is to be fitted up in the engineering laboratory of the Purdue University, the present engine, which has been six years in use, and has run the equivalent of 20,000 miles, being sent on to the road. The new engine, which, like its predecessor, is being built by the Schenectady Locomotive Works, will be arranged to work either compound or simple. Several sets of cylinders are to be provided, the largest being 30 in. in diameter.

The exports of steel rails, in tons, were as follows:

	1895.	1896.
United States	8,807	71,503
England	457,553	749,106
France	10,535	15,782
Germany	162,246	181,577
Belgium	86,452	97,572

It will be seen that the exports from the United States increased about eightfold in one year.—Centralblatt der Walzwerke.

A revolving observation tower is being erected at Great Yarmouth in honor of the Queen's Jubilee. The design comprises a strong hexagonal steel tower 150 ft. high by 14 ft. in diameter, surrounded by a circular structure or elevator. This elevator is raised and lowered by four strong cables, each of which is capable of performing the work alone. On this elevator is a circular platform fitted with rollers, and intended to revolve upon the elevator. This platform is provided with revolving chairs accommodating upward of 150 persons. While the elevator ascends and descends the tower the platform revolves around it, thus affording an uninterrupted and unsurpassed view of the surrounding country. The elevator is operated by powerful engines, and the platform is propelled by an electric motor.

A new balanced compound locomotive, which is the property of the Balanced Locomotive and Engineering Company, of New York City, has been received at Purdue University, where it is expected it will soon be tested on the locomotive-testing plant of that institution. The tests will be conducted by Professor Goss, acting under the direction of Mr. George S. Morison, vice-president of the company. From the peculiarity of the design of many parts of this engine, the results of the tests will be awaited with much interest by railway men. This engine is of the ten-wheel Atlantic type. It is a four-cylinder compound, each cylinder being independently connected to the driving axle. No eccentrics are used, the valve mechanism being operated conjointly from the crosshead and crankpin. The firebox also is a departure from the ordinary design.

In order to obviate the freezing of the Baltic canal, thus keeping it open for navigation as long as possible, says Die Vedette, the authorities tried to replace the fresh water of the canal by salt water; this could only be done from the Bay of Kiel, where the water contains on an average 1¼ or 1¾ per cent. of salt, while at the other end of the canal, in the Lower Elbe, the percentage is about one-half per cent. only, and the level there is far more affected by the tidal movement than in the Bay of Kiel. Now, by leaving open a sluice near Brunsbuttel during low tide, the salt water, entering from the Baltic end, was caused to gradually expel the fresh water through the other end of the canal, and at the present time, both in the canal itself and in the lakes through which it flows, the fresh water fauna and flora are more and more disappearing, and are being superseded by salt water plants and animals from the Baltic.

In an article in Timber, London, on the value of teak for structural and mechanical purposes, the claim is put forth that such wood is really the most durable timber known, and of special importance to shipbuilders, being very hard, yet light, easily worked, and, though porous, strong and lasting. It is soon seasoned, shrinks but little, and on account of its oily nature does not injure iron. In southeastern Asia it is not only considered the best material for ship construction, but for house carpentry and other work where strength and other lasting qualities are required. It is rarely attacked by ants of the white species, and its rare durability renders it specially valuable in a climate like that of India, where the elements causing decay are so numerous and powerful, where dampness brings on rapid decomposition, and where the white ant devours without scruple. In the operation of cutting this wood is frequently girdled one or two years before it is felled, and, thus exposed to the wind, the action of the sun, and to the pumping capacity of the leaves, it seasons rapidly, and is drier and lighter than timber felled green.

The transportation exhibit of the Transmississippi Exposition will have a novelty in the way of a miniature locomotive and train, said to be the smallest train in operation in the world, says the Railway Review. The engine weighs 450 lb., its nearest competitor being a London locomotive weighing 5,000. Its length, with tender, is but 6 ft. 7½ in., and the size of the cylinder 1½ by 2½ in. The tiny drive wheels are but 8 in. in diameter and yet it hauls six observation cars, in each of which two children can be comfortably seated. These cars are 41 in. long and 14 in. wide, and covered after the fashion of the ordinary observation cars in the East. The entire train, consisting of engine, tender, four observation cars, one box car and a caboose, is but an even 29 ft. in length. The engine carries 6 gallons of water in the tender tank and 5 in the boiler, which will furnish steam for two hours. Coal is hauled and shoveled out of the tender on the same plan that it is on the larger engines. In fact, the little engine is complete in miniature in every detail. Instead of using oil in the headlight, a little electric battery in the engine under the cab seat furnishes an incandescent which sparkles from the pilot like the diamond in a hotel clerk's shirt front.

ELECTRICAL NOTES.

The total production of electricity at the Paris centrals on the first of October, 1896, amounted to 1,775,000 watts from the dynamos and 1,610,000 watts from the accumulators.—Electrotechnische Rundschau.

In the month of April the erection of the telephone line from Berlin to Budapest was begun. It is to be completed in September, the total cost being estimated at 250,000 gulden, i. e., about $120,000. Of the total length, 1,000 kilometers, 440 are on German territory.—Electrotechnische Rundschau.

A car propelled by current from an accumulator covered the distance from Ludwigshafen to Frankenthal (Germany) at a rate of 50 kilometers, i. e., about 31 miles per hour. The car was an ordinary third class carriage in which the necessary arrangements had been made for electric propulsion.—Uhland's Wochenschrift.

The following extract from the Telephone Tariff at Stuttgart may interest our readers: Within the town limits, for a five minutes' conversation, 2½ cents; beyond these bounds, for the same time, 6 cents. The yearly subscription for one telephone line is $25 for distances less than three kilometers, and $6.25 extra for every two kilometers in addition.—Electrotechnische Rundschau.

An electric contribution box is the latest Connecticut invention, says the New York Tribune. The minister touches a button, and small silver cars, lined with velvet, visit each pew simultaneously, running on a slender rail back of each pew. Each car returns to a lock box at the pew entrance, and the deacons collect the receipts after the service. We cannot vouch for the item, however.

The electric tramway at Lausanne, Switzerland, is interesting in this respect that it runs up the steepest incline that is surmounted by any train or train depending on adhesion to the rails. The way from Place de la Riponne to La Ponthaise at one spot rises by 11·3 per cent. and in another by 8·2 per cent. The cars run at 6 kilometers per hour, and on one occasion a velocity of 12 to 13 kilometers per hour was reached.—Uhland's Wochenschrift.

The recently established electrical tramways in Cairo are a great success, and, notwithstanding the very low rates, which are sometimes less than two cents for a distance of three miles, they are being worked at a profit. The electric lighting is also being extended, and on account of the numerous overhead wires which are spreading in all directions, the government propose to issue rules which will have to be adhered to in all future installations.

The gold mines in Transvaal are supplied with electricity at a pressure of about 250 to 500 volts. Some of the mines are 20 to 25 miles from the dynamos, the force being transmitted by overhead lines. Every precaution is taken to provide against accidents. The voltage is reduced to the required level of about 120 volts by transformers. The total horse power transmitted is about 2,100; the charge is £45 per annum per horse power, i. e., much less than the cost of steam.—Electrotechnische Rundschau.

On the 31st of March of the current year a stock company was formed at Batavia (island of Java) for the construction and operation of an electric tramway system there. The capital amounts to 1,600,000 florins, i. e., about $800,000. The contract for building has been made with a German company. Two single track lines are first to be laid of together about 15½ kilometers length. On these there is to be one car for coolies and one for Europeans every ten minutes. According to the contract, the line is to be opened for traffic in May of next year.—Electrotechnische Rundschau.

A new method of obtaining light through the medium of electricity has recently been described by O. Schutt, of Germany. A spark from an induction coil is passed through a thin (capillary) tube, into the ends of which electrodes of copper or aluminum are inserted. The light produced is very brilliant, exceeding in this respect the light of the arc lamp. A great drawback is that the tubes wear out very rapidly, especially if very narrow; wider tubes give less intense light, and so do tubes from which the air has been partly exhausted. Owing to this rapid deterioration of the tubes, the discovery seems to have no practical value.—Uhland's Wochenschrift.

Perhaps in no other branch of technical industry is the use of electricity as a mechanical power so advantageous as in mining. In collieries the work is often carried on in many places, considerable distances apart, and no force can be so readily transmitted as electricity. Besides, in many cases, mountain rivers supply cheaply the required force for the production of electricity. In Europe and America, rock drilling, exploding, the transport of material, the pumping, ventilating and lighting of the plant, are done by such means. And recently the firm of Siemens & Halske, of Berlin, have laid a complete plant of this character in Tokio, Japan, and also in the Transvaal a similar one is in preparation, where four dynamo machines will work with a total horse power of 4,000; the current will be partly transmitted as far as twenty-eight miles.

More than twenty English railway companies have adopted a system of lighting the carriages by electricity, such that each van is quite independent of the rest of the train. On every carriage there is a dynamo and a storage battery so arranged that when one is at work the other is at rest. The dynamo is driven from the axle of the carriage, and is constructed so that the current is automatically kept uniform. At speeds less than 20 kilometers per hour the dynamo is at rest, and the storage battery only supplies the electricity. The conductor can switch off either one-half of the lamps or all. Each carriage has two lamps, in the first and second class carriages of 8 candle power each, in the third class carriages of 5 each. The additional weight of each apparatus is 4½ cwt.; the cost of installation, $350 per carriage.—Electrotechnische Rundschau.

MISCELLANEOUS NOTES.

The number of Hungarian patents issued in 1895 was 3,191. Hungarians received 615 patents, Germans 1,377, Austrians 650, Englishmen 144, Americans 136, and Frenchmen 128.—La Propriété Industrielle.

Among 1957 patents granted in Switzerland in 1896, only 603 were issued to Swiss citizens, Germans coming first with 689 patents. Frenchmen obtained 214 patents, Englishmen 131, Americans 92, and Austrians 80.—La Propriété Industrielle.

Attempts to free rancid cocos fat from its unsavory constituents have successfully been made at Thann, in Alsace. The patented process consists in acting on the best cocos fat with overheated steam, and then allowing it to cool hermetically cut off from contact with air, after the volatile products of the action are driven off.—Prometheus.

In Russia cotton spinning is the most important industry. In 1843 there were 3,500 spindles, each of which supplied some 33 pounds of cotton a year; now there are 5,000,000, and each produces more than double the amount formerly given. The material is supplied from the Caucasian Mountains and Asiatic Russia.—Uhland's Wochenschrift.

The name meerschaum, it appears, is derived from the word myrshen, which was used to designate the mineral at Brussa, in Asia Minor, where it used to be found plentifully. Meerschaum is a product of the decomposition of serpentine. It is, originally, a soft, claylike gray mass, which hardens to the well known white solid. Chemically, its composition is represented by the formula $Mg_2Si_2O_8.2H_2O$.—Prometheus.

There has been a considerable increase of stock companies in Germany, their number being at the present day 3,300. Of these 562 are banks, 127 insurance companies, 450 of the remainder are devoted to traffic and transportation. Foundries, mines and salt mines provide another 230 companies, and quarries 201. Porcelain manufacture is mostly private property, so only 13 companies of this branch exist.—Uhland's Wochenschrift.

For the measurement of very low temperatures, electricity is now usually called to aid. But if for any reason it is desired to use a fluid thermometer, which is to be practicable at the boiling point of atmospheric air (— 190° C.), the fluid best suitable is a mixture of hydrocarbons known as petroleum ether. This substance shows a remarkably strong contraction on cooling; at — 188° C. its volume is ⅛ of that at 0° C. and ⅓ of that at + 30°.—Stahl und Eisen.

Italy alone, to the present time, has adopted the 24 hour system for designating the time of the day. In Belgium it was to be introduced on the 1st of May, both for railways and for mail and shipping service. So far, the system seems to have met with little favor in Germany, but it is expected that there, too, a change will take place before very long. In France steps have been taken in that direction, and Switzerland is to adopt the new reckoning on May 1, 1898.—Uhland's Wochenschrift.

The province of Norrland, Sweden, which occupies nearly one-quarter of the whole realm, besides being covered with immense forests, is extremely rich in iron ores, which are as yet scarcely touched. The importance of these north Swedish mines is greatly increased by the fact that it is expected the iron ore of other origin which has come to the market plenteously so far will continue to do so for twenty years more only. After that time, the working of the Swedish mines may become a matter of necessity.—Uhland's Wochenschrift.

In spite of all efforts to increase the consumption of domestic coal in Germany, the importation of English coal is continually growing, being better and cheaper than any Continental produce. In 1895 England sent to Germany 80,000,000 cwt.; in 1896, 86,000,000. Of the additional 6,000,000 cwt., by far the greater part was burnt in Berlin. In the first two months of the current year the importation of English coal has gone back a little by some 800,000 cwt. In France, also, the importation of English coal has increased considerably.—Uhland's Wochenschrift.

A postal oddity is reported from Hanover. A merchant wished to send some circulars to a German customer in the form of cardboard rolls, and was greatly disgusted to find that they were rejected as printed matter, because their length exceeded the limit for German inland postage—45 centimeters. By parcel post they would have cost him some $625. But a way out of the difficulty was found. It appeared that the rules of the international postal union permitted a length of 75 centimeters. So the circulars were sent to Holland by express, and were then sent on from there at 4 cents apiece.—Uhland's Wochenschrift.

A new process for dyeing skins by the aid of electricity is described as follows: The skins to be treated are laid out on a zinc table, which serves as positive pole. Then the color which is desired to be imparted to them is poured on and is connected to the negative pole. The current passes and causes the color to pervade the skins. The process can also be modified and employed to trace designs on the surface by admitting the current (from the negative pole) by a copper plate which has been cut out in the design required. The parts covered by the plate show lighter coloring than the others, when the process is completed.—Prometheus.

A considerable amount of raw sugar used to be exported from Germany to England, where it was refined, and then further transported to the United States. Of late the export from England westward has decreased; the consequence being that more sugar has been exported to the United States from Germany and less to England. The exports from Germany to England, in 1892–96, are given below:

	Raw sugar.	Refined sugar.
1896	2,010,792	3,050,176
1895	3,156,401	3,231,814
1894	2,631,787	2,456,307
1893	2,519,147	2,106,625
1892	2,450,358	1,750,368

—Uhland's Wochenschrift.

THE ENGLISH MISSION TO HARRAR.

THE English mission, composed of Mr. Rennell Aodd, ambassador of the Queen of England, Colonel Wingata, attache of the Egyptian government, Count Gleichen, a relative of the Queen and attache of the minister of war, Lieutenant Cecil, Captain of the Horse Guard Bingham, Captain of the Engineers Swagne, representing the Indies, and Interpreter Speedy, made its entry into Harrar on the second of April, at half past nine o'clock. An escort of Indian lancers preceded and closed the procession. These lancers, of the garrison of Aden, were selected on account of their tall stature. The procession traversed the city between a row of Abyssinian soldiers.

After the official receptions a collation was served, and the mission, which had declined the offer of hospitality of Ras Makonnen, proceeded to establish its camp outside of the gate of Choa, at about half a mile from the city.

On the next day (April 3) Ras Makonnen visited the English camp and had a few minutes' conference with the different members. The mission returned the Ras' visit during the day, and continued its visits in beginning with the venerable French prelate, Mgr. Chauvin, Bishop of Harrar, and ending with one to the Russian mission of the Red Cross.

On the 4th of April the English mission assisted at the divine service of the Coptic rite, a ceremony at which likewise were present Ras Makonnen and Colonel de Maximoff, head of the Russian Red Cross mission.

A curious incident occurred at the moment at which the clergy presented the crucifix to be kissed by those present, and there was an instant of hesitation among the officiants when it became a question of presenting it to the English mission, which, according to the belief of the Abyssinians, was not composed of Christians. It became necessary to parley with the Ras, who gave orders to present the cross to it. The members of the mission kissed it devotedly, to the great astonishment of the assembled Abyssinians.

The mission now made its preparations for departure. It seemed to desire to hasten the moment of starting as much as possible, since the presence of Ras Makonnen inquieted it.

Upon the whole, it was an embassy and reception of politeness. As far as politics is concerned, the character of the Abyssinians is too well known to us to allow us to believe for an instant that they will lay aside the reserve that they have been able to preserve up to the present toward all the civilized nations that have thought it their duty to enter into relations with them.

Emperor Menelik II will doubtless receive Queen Victoria's ambassador handsomely, and will lend himself to all the exigences of the Abyssinian protocol in order to listen to explanations of the avowed purpose of the mission, and will reserve his reply. This will be a burial of the first part of the question, and everything will re-enter the primitive order after much ink has been spilled and much powder wasted on joyous salutes. Persuasion will have no more influence than threats upon the negro, who now feels himself strong enough to refuse to have any further discussion about anything that touches the independence of his people and the total integrity of his territory.

We present herewith a copy of a photograph of Serkis-Terzian sent on by M. Bavelaer, the explorer, now on a mission to Harrar. As this former Abyssinian chief played an important part in forcing the submission of Harrar to Menelik, the following notes concerning him will prove of interest in connection with the subject under consideration:

Serkis-Terzian, a native of Armenia, and endowed with an extremely adventurous character, went, when very young, to Abyssinia and entered the army of that country.

After traveling over Abyssinia in all directions, our hero finally stationed himself at Harrar during the year 1883 and witnessed the evacuation of this country by the Egyptians in 1885.

At the time of the accession of Abdulley, emir of Harrar, the fact that he was a Christian submitted him to all the vexations of that tyrant and of Mussulman fanaticism, and it was with a feeling of unrestrained joy that he learned of the Choans' preparation for war.

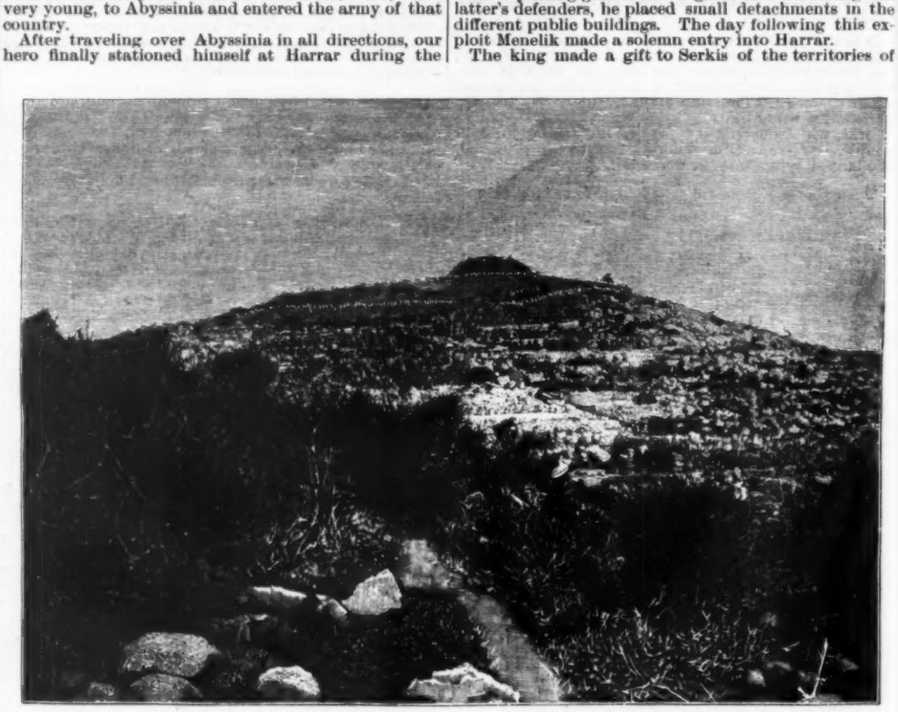
After the defeat of Abdulley's troops by King Menelik II and the flight of the emir to Berbera, the truly active role of our adventurer began. Deputizing him with other notable men of Harrar to bring to him the submission of that city, Menelik confided to him the mission of taking possession of the latter in his name.

Followed by twenty resolute, picked men, he, without striking a blow, entered the city in which, but a few hours before, he had been treated as a pariah and constantly menaced with death.

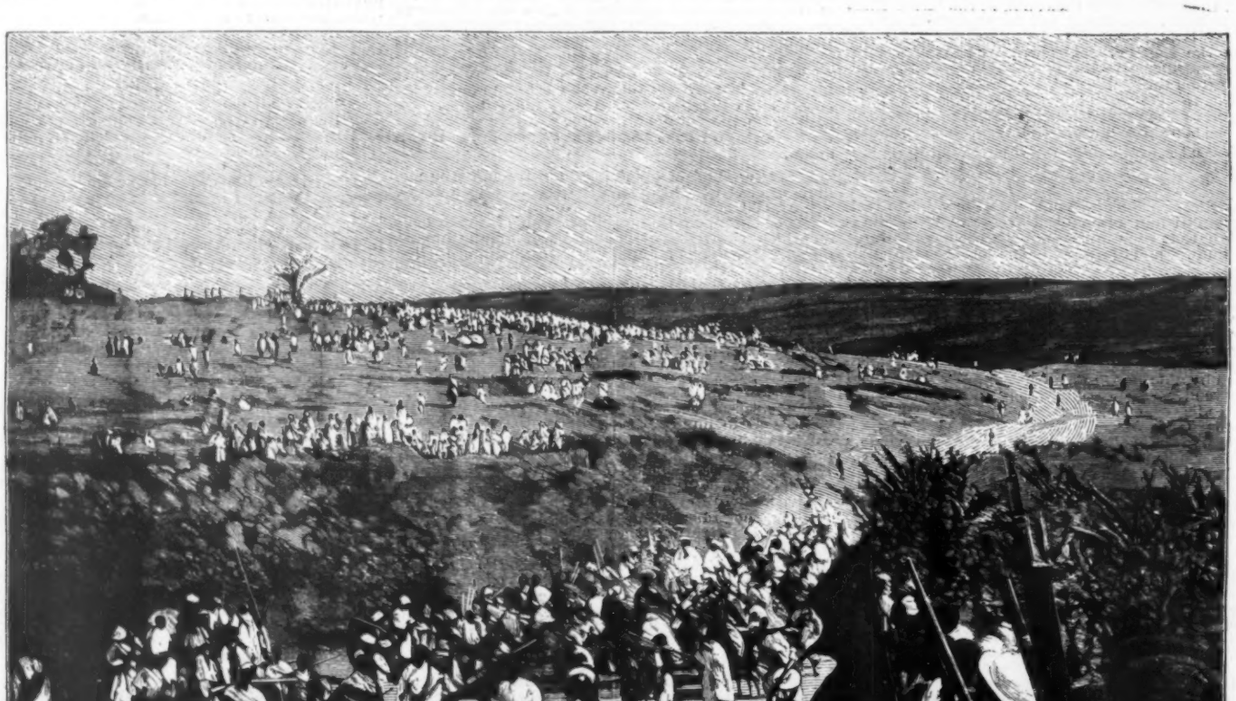
After putting guards at the gates and disarming the latter's defenders, he placed small detachments in the different public buildings. The day following this exploit Menelik made a solemn entry into Harrar.

The king made a gift to Serkis of the territories of Nole and Cambodia and of the tributes that he received therefrom, and then took him to his court. A few months later he was appointed governor of Gueldeissa, a very dangerous post at the epoch and one dreaded by the Abyssinians. Through a regime of terror and numerous expeditions he was enabled to submit the Somalis to the authority of the king, and extended the conquest of these territories as far as to Bijo Caboba. It was upon his return from one of these expeditions that the photograph reproduced herewith was taken.

Finally, tiring of this life of adventure, which would



RAS MAKONNEN AWAITING THE ARRIVAL OF THE ENGLISH MISSION UPON THE SUMMIT OF AOU ISSIN.



RAS MAKONNEN ON HIS WAY TO THE PALACE TO AWAIT THE ENGLISH MISSION, ABYSSINIA.

delight a writer of romances, Serkis retired to Harrar in order to devote himself to commerce. It was through the intermedium of him in great part that Menelik's army was provided with the first rapid fire guns that permitted this monarch to extend his authority and assume the independence of his states.

Serkis is still carrying on the business of selling arms, to which he has added a well stocked bazar, the management of which he has confided to his brothers, whom his new fortune has enabled him to call to his assistance.

At the time of the Armenian massacres he brought to Harrar, at his own expense, several Armenian families that had escaped the butchery, and also sent aid to the Armenian committee.

His repose seems to weigh upon him, however, and the adventurer is seen to awaken in him when, with legitimate pride, he is recounting to some one the number of his legendary exploits.

The fact that his life has often been threatened and that a price was once set upon his head by the English has robbed him of none of his somewhat savage joviality.—Le Monde Illustré.

THE FUTURE OF CENTRAL AMERICA.

By JOHN RICE CHANDLER, in the Iron Age.

FEW Americans realize that the shores of the several republics which constitute Central America are but an easy two or three days' steaming from our coasts. In fact, the everyday fruit steamers running between Puerto Barrios (Guatemala), Puerto Cortez (Honduras), Bluefields (Nicaragua) and Limon (Costa Rica), usually make the trip to New Orleans and Mobile in from four to five days and to New York in five to six.

If two other points were clearly understood—the climatic conditions and the so-called revolutions—a much larger proportion of our people would visit these republics, and, incidentally, good will and commerce would be enormously increased to mutual advantage.

As to the climate. That backbone of the country, the Andean chain, has determined the question of elevation, therefore of temperature. Although the whole land is within the tropics, all the central plateaus have an elevation of 2,500 to 6,000 ft., with a mild, temperate climate. The coasts, and the coasts only, as might have been expected, are hot and sultry, and in some places unhealthy. All the cities and large towns are located, with few exceptions, in the temperate regions.

With regard to uprisings. These republics for over fifty years were continually in the throes of revolution. Some twenty years ago things reached a crisis, and the people at large seem to have become convinced that nothing but ruin and death was to be obtained by the methods till then pursued. Since then uprisings have taken place, but they have seldom lasted over a few weeks, and, but for a few sensational correspondents, never resulted in any particular harm to life or property.

As year after year has gone by and the Central Americans have been placed in closer contact with the outside world, they have developed a great desire for advancement in every line of life, and have shown this practically by the rapidity with which they have come into line with modern nations. The telegraph, telephone, electric light and steam railways are all to be found in ordinary use in each and all of the five republics. Modern machinery is found in the factories, the sugar, coffee and tobacco plantations. In fact, except among the lowest stratum, the people have the ways and manners, the amusements and ambitions of Europeans.

So far, foreign immigration has been slow to appreciate the favorable conditions presented by these countries, but now that such countries as the Argentine Republic, Brazil and Uruguay are relatively well supplied with foreign population, Europe is looking toward Central America as a future receiver of her surplus population. And well they may, for eight-tenths of the land is temperate in climate, and no more valuable crops can be obtained in any country.

Although large tracts of land are already taken up with the cultivation of sugar, cacao, tobacco, rubber and coffee (the latter alone producing a yearly crop valued at upward of $40,000,000), there are still hundreds of thousands of acres of land waiting to be put under cultivation, just as good in every way as that now producing. Most of the East Indian spices and medicinal plants could easily be grown in these republics, with the result that, like our coffee and cacao, the finest grades and best prices would be obtained. Another source of wealth is tobacco; it is grown successfully in the sheltered sections of Zacapa and Cojutepeque, as well as in Honduras, but with careful cultivation, selection, and last, but not least, capital, a product in nearly every way equal to the Cuban weed could be produced in large quantities and on virgin soil. That is a thing which to-day is impossible in Cuba.

Capital would immediately bring more railroads. At present there are nine lines running or in construction, but the interior of all these five countries remains to be opened up. When the Guatemala Interoceanic and the Costa Rica Railroad from the Atlantic to the Pacific are finished, a great impetus to commerce will surely have been given, but these republics will still be quite as far from one another as they are to-day. A series of branch lines will be needed to ramify through the rich sections of the interior, and then a north and south line running from the Mexican border and tapping their railroad system at or near Tapachala; following the Pacific coast line, this railroad (already surveyed by order of the United States government) would traverse Guatemala, Salvador, a part of Honduras, Nicaragua and Costa Rica, finally joining the South American railway system at Panama.

Not only would such a line have great value from a commercial point of view, but it would be equally important from a political one. The interests of the five sections of Central America are naturally in the direction of political union. Their language (Spanish), customs, ideas, and traditions, constitutions and general laws, are the same, or at least very similar, throughout. What is most needed at present is frequent and rapid intercommunication from Guatemala on the north to Costa Rica on the south. This is the only way to bring about a universal feeling and desire among the masses for union. The experiment in this direction, now being made by Nicaragua, Honduras and Salvador, is certainly very laudable, but the people do not seem to take "La Republica Mayor," which they have formed, very seriously as yet. The sections are still too far away from one another to feel the benefit of such a union. But little can be done in this direction as long as it takes fifteen or even twenty days to travel from one section of the country to the other, as is now the case. Notwithstanding, the union of the five republics under the Central American flag is bound to come. The better classes are beginning to see the great advantage of running one government instead of five, with all the attendant expense. Furthermore, they see clearly that a country with upward of four million inhabitants would have greater respect shown it by the rest of the world than under the present arrangement. They clearly understand that a new country, with a stable, honest government, rich in raw material and already producing large crops of the most valuable staples, would have many more chances of attracting American and European capital as well as immigration of the better elements.

The Central Americans point with pride to their splendidly appointed coffee and sugar plantations, equipped with the very latest types of machinery, whether for drying, cleaning and hulling coffee or mills and pans for sugar.

All this is not a circumstance to what the number, size and equipment of plantations will be, once the republic of Central America is erected on a solid basis and Americans realize that they have such a land of promise but a couple of days' sail from their own shores.

Perhaps one of the most important, if not the greatest element in the bringing about of favorable conditions in these republics, is the building of the Nicaragua Canal by Americans. The real patriots among the Central Americans see that it needs the moral and financial backing of a great and friendly power to push such a gigantic work to a successful end. They, therefore, prefer a partnership with the leading republic of the world to any inducements held out to them by European monarchies. To those who still have doubts as to the great commercial value of the canal the perusal of the statistics got up by the British to show the trade and estimated traffic through the canal is recommended. The tonnage from the United States to Asia and the Pacific coast of Spanish America is placed at 1,200,000; that between American and South American ports and Europe, 500,000 tons; trade between Europe, Asia and Australia, 2,000,000 tons. Among other reasons that might be put forward to show American capitalists, manufacturers and merchants that the present is the very best time to interest themselves in Central America, notwithstanding the depression caused by the fluctuation in silver prices, is the one that, in contrast to several South American countries, business is not yet overdone; openings in nearly every line can be made with moderate capital to yield handsome profits. Of course, it stands to reason that such rich territory will not long go begging, once the world is fully alive to the fact that life and property are as safe there as in almost any other part of the world.

SERKIS-TERZIAN, EX-GOVERNOR OF GUELDEISSA.

HOW TO AVOID TAKING COLD.

THE fin de siécle toilet is not complete without rinsing the mouth and spraying the nasal passages and the throat with an antiseptic solution night and morning. By these means the upper air passages are kept in an antiseptic condition, unfavorable to the development of germs, and disease is prevented. G. Lemoine, in the Nord Med. (Jour. Am. Med. Assoc.), states that numbers of persons by these simple precautions have passed through the winter and rainy spring without once catching cold, although they had previously been extremely sensitive, and troubled with severe colds much of the time. He recommends to rinse the mouth with a glassful of fifty grammes Labarraque's solution mixed with one liter of water, or the following: Thymol, 0·50 gramme; alcohol, 20 grammes; water, 1 liter. With an ordinary toilet atomizer the nasal passages and upper part of the throat should be thoroughly sprayed with some solution like the following: Phenolsalyl, 0·50 gramme; chlorid of sodium, 3 grammes; distilled boiled water, 500 grammes. He adds that the teeth should be well brushed, and the fingers never put in the mouth or nose. A few menthol drops should be carried in the pocket and dissolved in the mouth occasionally. He concludes with the remark that a friend of his has always succeeded in breaking up a cold in the early stages, by taking during the first day four to six capsules or pills of essence of turpentine in addition

to the rinsing or gargling and spray, with a glass of purgative water the next day, followed in a few hours by 0·50 centigramme of quinine.

THE SURGICAL STATUS OF THE BICYCLE.

FOR twenty-five weeks during the wheeling season, the Buffalo Express has collected statistics of accidents occurring to bicycle riders in the streets of that city. Before quoting figures, some preliminary remarks may be in order to call attention to their general significance.

Cold blooded as it may seem, it is necessary for the surgeon, like the physician of any branch of practice, or like the man engaged in business of whatever kind, to inform himself as to the sources of his employment. It is not simply with regard to the fullness of his pocket book that the obstetrician notes the average number of births to each marriage, or that the surgeon is interested in the influence of steam railroads or of trolleys on his practice. As a matter of practical philanthropy, it is desirable that every one should anticipate, so far as possible, the demands which are likely to be made upon him, while sociologic questions are solved only as each worker notes the influence which the various institutions of civilized life have upon the welfare and detriment of the human race, so far as his own possibilities of observation extend.

The statistics gathered by the Buffalo Express ought to be fairly representative. The city is one of the second magnitude, having—exclusive of suburbs—about 350,000 inhabitants. One in seven of these, or about one in four, who may be expected to use the highways, ride bicycles, to some extent. Although supplied with over two hundred miles of smooth pavement, the majority of the riding, both by men and women, is for business and therefore on downtown streets. These are not so wide nor so empty as might be desired by cyclists, still there is no such crowding as occurs in New York and Boston, none of the tortuous and narrow streets of the latter and none of the bad pavements which still linger in Philadelphia. On the whole, the conditions are as favorable as can well be expected without being ideal.

The Express has chronicled, between April 15 and October 10, sixty-three bicycle accidents serious enough to involve medical attendance. The editorial writer also states that he personally knows of a number of cases that did not get into print and estimates the total number of accidents as about one hundred, or four per week. No deaths have resulted, although many of the injuries were, at first, thought to be fatal. The distribution of these accidents, so far as time is concerned, is about equal for May, June, August and the parts of April and October covered by the statistics. Five accidents occurred in July and sixteen in September. The increase for September is correctly ascribed to the greater amount of traffic. The minimum for July was probably due in part to the diminution of business, the absence of wheelmen from town and the relatively greater use of uptown and suburban streets. The Express explains an increase of accidents in May and June as probably due to the large number of novices riding, but the figures given do not show any such increase. Forty-one, about two-thirds of the cyclists injured, were men, indicating a relatively greater liability on the part of women. This is explained, not only by differences in dress and general physical development, which work to the detriment of the female sex, but by the common observation that women cyclists carry more bundles than men, and, therefore, have their wheels under less perfect control, and that they also take chances that none but the most reckless male riders would dare.

These statistics show in the most convincing manner that the popular notion as to the prevalent carelessness of cyclists is totally wrong. Only six serious accidents to pedestrians can be charged against 50,000 wheels in half a year, and it is more than possible that some of these six may have been partly, or wholly, due to carelessness of the injured persons. Moreover, of the sixty-three injured bicyclers, only five had suffered from collision with other cyclists, representing, probably, not more than three serious accidents, since apparently the figures refer to the number of injured persons and not to the number of collisions. In other words, these 50,000 cyclists, riding for half a year—and the half during which wheels are most used—threading their way in and out through crowded streets, sometimes in such swarms that one might count a hundred or two in walking a block, are responsible for only about ten collisions with serious results. Four riders collided with trolley cars and one or two each with telegraph and telephone poles, trolley posts, curb stones, lamp and sign posts, etc.

In contrast with these meager figures, we learn that twenty-five of the injured bicyclers had collided with vehicles drawn by horses. The figures lend color to the general opinion of wheelmen that many drivers of delivery wagons, moving vans and hacks not only do not do their share in trying to avoid collisions, but take a malicious pleasure in cramping suddenly on the wheelman or otherwise blocking him and letting him avoid disaster—if he can. Many of those who are not malicious are criminally careless.

It should also be noted that, in all probability, many of the cases in which bicyclers have run into poles and curbs are directly due to crowding by vehicles. In one such case—whether included in the list or not, we do not know—a wheelman was deliberately crowded to the curb by a hack driver and fell, sustaining a compound fracture of the leg.

We are not aware that there is any characteristic injury resulting from bicycle accidents. The rider is supported by feet, perineum and hands, so that no one part of the body suffers the entire force of impact. The direction of the collision, the rate of speed, the objects against which the wheelman falls, or against which he may be driven, his attitude on the wheel, all influence the lesion which he may suffer. It must be borne in mind, also, that a cyclist does not suffer one fall unless he is precipitated over an embankment or has some similar accident, but is pushed sideways by his momentum, after he strikes the ground, without being able to free himself from his wheel or to stand upright. Thus, he may sustain injuries to his knees, hands, shoulders or head, according to his efforts to save himself and according to the direction in which he stumbles. Those who do not ride bicycles, almost without exception, overlook the fact that the cyclist not only suffers the force of collision, but also the results of this pushing, stumbling fall.

The pedestrian often imagines that it is sport for the wheelman to run him down, and the comic papers have a large file of jokes to this general effect. The pedestrian, already on the ground, is struck by an air cushion, or is whirled out of the way by the fork or handle bar. The wheelman, on the other hand, bears the brunt of the collision on the perineum, and also receives a bad fall.

Much has been written on the dangers of wheeling, medical and traumatic, but we believe that actual statistics, as to the result of street accidents, are rare.—The Medical and Surgical Reporter.

REMARKABLE EXPLORATIONS IN BABYLONIA.

A CORRESPONDENT of the Times says that Mr. Haynes, who for nearly five years has been in charge of the American expedition excavating the great mounds of Nuffar, in Northern Babylonia, has unearthed the ruins of the oldest city in the world, the foundations of which were laid some six or seven thousand years before the Christian era.

The work was begun in 1888 by the University of Pennsylvania, the funds being provided by a small committee. The expeditions of 1888–90, under the direction of Dr. Peters, produced a harvest of about 10,000 tablets and inscribed objects, among them several records of Sargon I and his son Naram-Sin, whose date B. C. 3800 was by many regarded as the starting point of Babylonian history. Troubles among the Arabs and the usual difficulties with the Porte delayed the work for three years. In 1893 the explorations were renewed under the charge of Mr. J. H. Haynes, and they have been carried on continuously ever since, and have produced results such as were never dreamt of even by the most ardent advocate of Babylonian explorations, and the history of civilization has been carried back to an antiquity never thought of. The methods of systematic research such as were employed by Curtius, Schliemann and Petrie, laying bare stratum after stratum of the ruined city, noting with care the position of every object, and above all the aid of photography, had never been applied until now. By this method the history of the excavated city may be read like a book, each stratum as it is uncovered furnishing us with a chapter of its long lost history. The story of Nippur as read in its ruins is indeed a remarkable one.

The great mounds of Nuffar are situated on the east bank of the now dry Shat-en-Nil, a great main artery navigation canal which once connected Babylon with the Persian Gulf. The central feature of the ruins is a vast conical mound, called by the Arabs Bint el Amir, "the Amir's daughter," which rises to a height of nearly 29 meters above the surrounding plain. This mound marks the site of the great ziggurat or temple stage tower first built by Ur-Gur, or Ur-Bahu, as he was formerly called, about B. C. 2800, and subsequently repaired and added to by later kings. This vast structure was the central point of the explorations by Mr. Haynes.

The arrangement of this temple and tower of Ur-Gur bears a most striking resemblance to the early Egyptian pyramids. At no period in early Chaldean history was there so close a contact between Egypt and Chaldea as during the dynasty of Ur-Gur Dungi and Gudea of Lagash. These rulers, as we know from their numerous inscriptions found at Tello by M. de Sarzec, were in constant communication with Egypt by sea and through the Sinaitic peninsula. It was from this region that they obtained the hard diorite and porphyry for their statues and door sockets. The statue of Gudea, seated and holding the plan of a temple on his knees, is most Egyptian in character, the attitude resembling that of statues of Khafra and Menkara; moreover, the scale engraved upon the tablet gives the Egyptian and not Chaldean cubit. The tower rests upon a massive platform of crude brick. Excavations conducted below this revealed the existence of a second pavement of much finer construction, being built of kiln-burnt bricks of great size—the dimensions being 50 cm. square and of great thickness. Nearly the whole of these bricks were inscribed, and bore the stamps of Sargon I and Naram-Sin, his son, and its date, therefore, is just a thousand years prior to the buildings of Ur-Gur—namely, B. C. 3800. From the inscriptions of both these kings we know that they both built large portions of an older temple of Mullil.

Northwest of the temple was a line of mounds marking a rampart, and Mr. Haynes in 1895 cleared a portion of it and unearthed one of the most extraordinary pieces of masonry ever discovered. The foundation consisted of a solid bed of clay mixed with straw and puddled down, resembling some of the constructions found by Dr. Schliemann at Hissarlik. Upon this foundation and plinth was constructed a solid brick wall, 52 feet in thickness and rising to an unknown height. The builder of this wall was Naram-Sin, whom so many have regarded as a mythical king. It is probable that this rampart formed also a broad roadway round the city, and it may possibly, as Mr. Haynes suggests, have had a row of chambers in its upper part. Directly southeast of the great tower and close to the great rampart Mr. Haynes discovered a chamber with no doorway—it was evidently a vault entered from above, and was built by Ur-Gur. This and a second chamber immediately below it were the archive chambers of the temple, which had been partly restored by Ur-Gur, while the second was that of the king, built up to the level of his own pavement.

It is clear that at some time between the time of Ur-Gur, B. C. 2800, and the rise of the Kassite dynasty, B. C. 2200, the archive chamber had been broken into and large numbers of objects carried away and the rest broken and scattered. There can be little doubt that this disaster took place during the terrible Elamite invasion in B. C. 2285, when all the principal temples were pillaged and their treasures carried to the Elamite capital. We have proof of this afforded by a small disk of agate found in the ruins, which bears on one side a dedication by Dungi to Mullil, and on the other a dedication by Barnaburyas, B. C. 1400, which states that it was taken from "the palace of Susa in the land of Elam." The amount of debris from the pavement of Naram-Sin to the top of the mound is 11 meters in height, and this, we know, took close on 4,000 years to accumulate. Mr. Haynes, encouraged by the success of his work in the upper stratum, proceeded to excavate to reach the virgin soil, which he did at the depth of 9·25 meters, passing through the debris of ruined buildings, accumulations of broken pottery, and fragments of inscribed stone objects and well constructed drains. These remains prove the existence of at least two temples below the pavement of Naram-Sin, which at the most rapid rate of debris accumulation cannot be assigned to a later date than between six and seven thousand years before the Christian era. This lowest stratum has been much disturbed and the buildings pillaged; still, sufficient remains to reveal to us earlier phases of Babylonian civilization than we have ever seen. The first structure discovered was an altar of sun dried bricks, 4 m. by 2·46. The upper course had a rim of bitumen, and upon the altar was a large deposit of white ashes. Round the altar was a low wall marking the sacred inclosure. Outside of this inclosure were found two immense vases of terra cotta. These great specimens of early pottery were each 63·5 cm. high and decorated with rope pattern. We have here in this simple, sacred precinct the germ from which sprang the great temples of Chaldea—the altar, with its teminos, entered only by the priest, and the two great vases for purification, replaced in after times by the greater and lesser absu, placed before the temples. A somewhat similar construction was discovered at Sippara, but its archæological value was not recognized. Southeast of the altar was found a remarkable structure, a brick platform, 7 m. square and 3·38 m. high, built of fine unbaked bricks. Round the base of this Mr. Haynes found a quantity of water vents, which indicated a connection with some receptacle below, and on sinking beneath this solid mass he found a drain passing underneath the platform, in the roof of which was the earliest known keystone arch. It is 71 cm. high and has a span 51 cm. The bricks are well baked and joined with stiff clay as mortar. Thus the priority of Chaldea in the use of the keystone arch is clearly established.

This structure was over 7 m. below the pavement of Ur-Gur and 4·57 below that of Naram-Sin, and, since there were no massive ziggurats or great temples to crumble into ruin, it must have taken many centuries to build up so great a mass of débris, and an estimate of from 1,500 to 2,000 years before the time of Sargon does not seem too high.

Over 26,000 tablets as well as numerous inscribed fragments of vases and stelæ have been recovered from this site. It is therefore clear we have no lack of material. Under a pavement of Ur-Ninip, a king of the dynasty of Ur-Gur, were found some hundreds of broken vases and other objects that had been votive offerings to the shrines of Mullil from the earliest times. Among these were some of the most archaic type, and Professor Hilprecht, almost at the loss of his eyesight, has constructed a complete text of 132 lines written in a most archaic character. These records relate to a series of primitive wars and form certainly, whatever their age may be, the oldest historical records known. The earliest of these is the inscription of "Eshagsagana," styled "lord of Kengi," that is, Lower Babylonia, in whose time the chief enemy of Babylonia was the city of Kish, the modern El Hymer, whose priest ruler had entered into alliance with some fierce tribes called "the hosts of the Land of the Bow." The first inscription describes how the Babylonians "conquered the king of Kish and his ally," and spoiled his city. The next inscription is one of the king of "hordes of the bow" who had had his revenge and conquered Babylonia. The conqueror describes his empire as extending from the Lower Sea of the Tigris and Euphrates to the Upper Sea (Mediterranean), and as being granted dominion over all lands from the rising to the setting of the sun, whom he has caused to dwell in peace.

Who were the "hordes of the land of the bow"? Professor Hilprecht has put forward a theory that they are to be identified with the Semitic tribes of North Mesopotamia, and that the "City of the Bow" was Harran. It is rather (our correspondent says) to the plains of Central Mesopotamia and the lowlands between the Tigris and the Kurdish mountains that we must look for the home of these nomadic warriors.

This exploration reflects much credit on its organizers and, above all, on Mr. Haynes. For thirty-two months he lived alone among the wildest Arab tribes in Mesopotamia, in an atmosphere of fever varied with cholera. One determined attempt was made upon his life; yet amid all these surroundings he lived and did the work of three men. He is entitled to a place in the front rank of explorers along with those who have restored to us the first chapters of the world's history.

DRIVING OSTRICHES.

POTCHEFSTROOM, or Moori River Dorp, was the second seat of government of the Transvaal, the first having been Origstadt, which, being in the low bush country, was first decimated by fever and then deserted; from Potchefstroom the seat of government was removed to Pretoria. It was an out-of-the-way place, and was seldom visited by English, except by hunters and traders on their way to the Zambesi, Lake Ngami and the Matabele and Bamanwato countries, and in the colonies it was very rare to come across any one who had been there. On our way back we purchased at a farm four young ostriches, a few months old, and not quite half grown. We had considerable difficulty in getting them off the farm. A little further we bought three more, a little older and three parts grown, and these gave us proper work to get them away. For a whole day we were chasing them all over the country on foot, for we had brought no horses, not anticipating this kind of work; but they always returned to the house, and toward evening we gave it up. In the morning at daybreak we spanned or hobbled them with silk handkerchiefs, and in this way managed to get them six or seven miles from the farm.

The next day we removed the handkerchiefs, as they were injuring the birds' legs, and for a little while they went along quietly, until they sighted a troop of wildebeestes, when they stretched out their necks and were off at their best pace to join them. We then each seized one of the two wagon whips we had and started after them. If the birds had been real wild ones and full grown we might as well have

ted after an express train, for I never sat the horse could run down a full grown ostrich in a fair ce; but they were only three parts grown, and been domesticated on a farm since they came out the egg, and they were really more indulging in bols than making a serious attempt to join the lebeestes. Consequently, we succeeded in driving n back, but the performance was repeated fifty s during the day, and we had not a moment's the whole day. It was quite dark when we at rth arrived at the river, and but for the assistance he rest, who came to our aid, we should never have them through. At camp we threw ourselves exsted on the ground, and both declared that it was far the hardest day's work we had ever done in our s. The distance we had run after those wretched ds was certainly over fifty miles, and for the ater part of the distance we were cracking heavy gon whips as well.

hese ostriches were afterward a source of endless uble to us. They grew rapidly, and developed at kicking powers, until they became sometimes itively dangerous, the dogs and the Kafirs coming for most of their attentions. Their appetite was inable; we used to make large quantities of biltong, sun-dried meat, and there were usually dozens ps of it hanging on rheims slung from wagon to gon, and these were always objects of attention on part of the ostriches. It was most amusing to see trying to swallow a strip a yard long and two hes thick, just as a chicken struggles with a worm t is a little too big for it. Once we had to drag a e strip out of one of the birds' throats to save it choking. But it was the culinary department t interested them most. They would always attack Kafirs bringing the viands from the "kitchen" to tent, and sometimes were so pertinacious that the would get frightened and throw the dish away bolt, and we would lose the best part of our din-. They would even come into the tent and snatch gs off the table, and we would take it out of them smothering a dainty morsel with salt and cayenne per; but after a while they seemed to flourish on

One day, however, we got the laugh on our side. ner was preparing, and one of the birds was instigating the pots round the fire; a great pot of e potatoes took his fancy, and he incontinently ed and swallowed a red hot tuber as big as a large megranate. He danced, he jumped, he kicked, he sted his neck about almost into knots, he flapped wings and waggled his tail, he ran amuck, knocke things down and banging himself up against e wagons and stone walls, and at last tore away into veld at twenty miles an hour, until he was out of ht, and did not appear again for a couple of hours.

very morning, soon after sunrise, these birds would dulge in a dance. They would rush away into the d for about a mile, and then suddenly stop and mmence waltzing round and round in the most ridulous fashion, often till they dropped. I never uld understand the meaning of this performance; might be mere gamboling, but if so it must be arly the only case of young birds playing, as so ny young animals do. Their keen sense of sight s often been noticed, but it is not generally known at their sense of hearing is quite as acute, and if ey were feeding two or three miles away, a few alies (maize) rattled in a tin pannikin would suffice bring them back.—South Africa.

THE INTELLIGENCE OF ANTS.

o the Editor of the SCIENTIFIC AMERICAN:

I have often thought that some of the conclusions vanced by Sir John Lubbock in his great work, Ants, Bees, and Wasps," were, to a certain extent, roneous. Furthermore, I believe that these faulty ductions on the part of this observer were the result the unnaturalness and the artificiality of his experients.

In almost every experiment conducted by Sir John, d detailed in the book referred to above, the ants ed were placed amid artificial and specially prepared paratus; hence, amid new surroundings with which ey were utterly unfamiliar.

When we take into consideration the fact that, to an t, in all probability, every stalk of grass is a forest e, every bowlder a high and lofty mountain, and ery minute crack or crevice in the ground a crevasse abyss of appalling depth, we will readily compreend the fact that, when they are transported any disnce from the nest and placed among unfamiliar enes, they must necessarily be handicapped by a perctly natural bewilderment. Man himself, with all his vaunted intelligence, would find himself at a loss nder like conditions. When studying the psychology the lower animals, they should be observed, I take among natural conditions; experimentation should e as inartificial as possible.

Ants soon arrive at a thorough knowledge of the untry surrounding their nests; they very soon beme familiar with the "lay of the land" over which ey range. Hence, in the following experiments and bservations, I have observed the ant at home; I have ot placed an additional and unfair burden upon her telligence by transporting her to a foreign country id unknown scenes. Furthermore, I have not taxed r ratiocinative powers beyond their physio-psychogical limits, as was done in more than one of Lubock's experiments.

In front of my house there is a paved walk ten feet oad and three hundred feet long. Beneath the icks of this pavement are the homes of several species ants. These ants were the subjects of my experintations, and this pavement was the place where e experiments were made.

In summing up his observations on the extent to hich vision aids ants in finding their way, Lubbock ys that ants, at least the species (Lasius niger) exerimented with by him, guide themselves but little, if all, by sight. I am convinced that this is an error; n error engendered, first, by the unnecessary articiality of his experiments; second, by his ignoring e limit of the range of vision in L. niger.

Two larvæ or grubs of L. niger were placed on a ickel five cent piece some ten inches from the nest nd a marked ant put to them. She examined them arefully, then, picking up one, she carried it to the est. While she was absent, I placed another grub on the coin. She soon returned and again carried a larvæ into the nest. While she was absent on her second trip, I moved the coin and larvæ some eight inches to the right. When she returned, she passed over the original spot, then circled about as though looking for the desired object; finally, after several minutes' search, she entered the nest without having found the coin.

I performed this experiment repeatedly, gradually lessening the distance between the two points until I arrived at the distance of 1 in. between the spot made familiar to the ants by repeated visits and the point to which the larvæ were removed while the ants were absent. The ants seemed to be able to see the coin and larvæ at this distance, for they went to them at once, as soon as they discovered that they were not at the accustomed place.

This experiment was repeated time and again, always with a like result. At any distance over 1 in., however, the ants appeared nonplussed, and immediately began to hunt here and there for the coin and grubs. I believe that I do not claim too much when I assert that the ants were able to recognize these objects, at least at the distance of an inch. Moreover, I had reason to believe that their range of vision extended even farther, for on several occasions I had seen them turn and flee when they had unwittingly strayed within two or three inches of a "devil's race horse" (Phasmomantis carolinæ). I therefore tested their vision for greater distances in the following experiments:

I put several larvæ on a pillar 4 in. high and 2 in. thick. This I placed some distance from the nest, and, after I had accustomed a marked ant to the road between the pillar and the nest, I moved the former and stationed it some 10 in. away. The ants were unable to see it at this distance, but when the interval had been reduced to 2½ in., they found the pillar without difficulty. Experiments with larger objects, at greater distances, amounted to nil. Hence, I think that the extreme range of vision in L. niger approximates 3 in.

In order to determine whether or not smell was absolutely necessary in finding their way, I proceeded as follows:

Between the pillar and the nest (and thereby bridging one of the sulcii between the bricks) I placed a piece of writing paper, 2 in. long and 1 in. broad; this bridge was directly in the ant's established pathway. When the ant arrived at the paper, she stopped, then turned and retraced her path several inches toward the nest; she again turned, walked across the paper and made her way to the pillar. When she first arrived at the paper, she evidently recognized the fact that here was something new and unknown in her path; bewildered for the moment, she turned and went back; finally, however, her sense of direction triumphed—she knew that the pillar was in a certain direction and that that direction was beyond the paper, so she traversed the bridge and went on her way to the pillar. It is hardly possible, nay, I believe that it is impossible, that she smelled out her route through the paper; indeed, I noticed that she followed the edge of the paper at least a half inch away from her old route.

Lubbock made an ant pass between several wooden blocks on her way to and from some food; he then changed the direction of the blocks until the space between them was tangential to the old route. Yet the ant invariably followed her accustomed path without noticing the blocks. He gives this as evidence substantiating his claim that ants are not guided by sight. I do not think that this is a fair conclusion. Suppose a man follows the footprints of another man through a lane which has a fence on each side; suppose these fences are changed during the night so that they will run tangential to their old site; must the man traverse the space between the fences if he desires to again follow the footprints?

I believe that the microscopic eyesight of the ant seizes on objects immediately at her feet—objects so infinitesimally minute that we have no cognizance of them at all. I believe that it is by such landmarks that she marks out and recognizes her route to and from any point. Of course, that most wonderful sense, the sense of direction (which all animals, save man, possess in some degree), has a great deal to do with the guidance of ants, but not all, by any manner of means. Even blind ants follow corridors, passageways and tunnels; hence it would seem that touch, and not smell, was the guiding sense, at least in blind species.

Again, in order to further investigate this question, I made a company of ants pass over a paper bridge on their way to a pile of bread crumbs. After the route had been well established and the ants had been passing to and fro over the paper for some time, I removed the bridge and placed it across another line of march which had been established by another company of ants which was busily engaged in carrying some larvæ into the nest. The paper bridge was placed athwart the line of the larvæ carriers, yet these latter did not appear to notice the trail of their companions on the paper, but crossed it at a right angle and passed on to the larvæ or to the nest.

Lubbock's experiments are always exceedingly elaborate, and it is this very quality of elaborateness which, in my opinion, very frequently militates against a correct result. He is rather disposed to question the often repeated and well authenticated statement that ants disinter comrades which have been accidentally buried, simply because, in his highly artificial experiments, they failed so to do.

Probably, if he had dispensed with his intricate and elaborate apparatus, consisting of "a vessel containing honey, which vessel rested in another containing water; a shallow box containing powdered earth; a paper bridge, etc.," and had experimented, naturally and inartificially, with ants which were at home and amid well known and familiar surroundings, his results would have been different. Moreover, in his experiments, he expected the ants to solve problems which man, with all of his intelligence, would find absolutely and entirely beyond his powers.

He accustomed some ants to cross a box of powdered earth on their way to a vessel of honey; after they had learned the route, he buried several of them in the powdered earth. "At 7 A. M., the next morning, the honey was all gone, two or three were wandering about, but no notice had been taken of the prisoners, whom he then let out."

Suppose a company of desperadoes seized a man and buried him in the middle of the public highway; suppose, also, that no one saw this burial save those who committed the outrage, that it was utterly unknown; is it at all probable that passersby on that highway would discover that a man was buried in the road? And yet, Sir John expected his ants to solve just such a problem!

That ants, on occasions, do disinter buried comrades cannot be questioned. Whether or not they are influenced by affection and pity to render aid to their hapless kindred, I know not; yet the fact remains that they do.

Seating myself beside a nest of Lasius flavus, I noticed that numerous small workers were bringing up the earth and depositing it in a circle about the entrance. Several large workers were walking about, seemingly directing the small workers where to lay down their loads. Seizing my opportunity, I suddenly buried three small workers beneath a pinch of sand. The large workers immediately hurried into the nest, from which, in a few seconds' time, there issued a crowd of small workers which at once began to remove the sand. In a very few moments the buried ants were disinterred, and were then carefully cleaned by the tongues of their rescuers!

In this experiment I endeavored to imitate a natural phenomenon. I produced a catastrophe, which, doubtless, frequently occurs to ants in a state of nature. A sudden and violent gust of wind or the busy feet of some industrious fowl have, unquestionably, often brought about just such miniature avalanches of sand.

Again, I glued an ant by one leg to a brick with some quick-drying cement. The struggling creature was soon discovered by some of her sisters, which at once began to free her by eating the glue about her feet. They quickly set her at liberty, but did not abandon her until they had thoroughly cleansed her. Thinking that, probably, they were influenced by a personal motive, i. e., that they ate the glue because they liked it, I mixed some quinine with it and then fastened another ant to the brick. She was soon surrounded by several comrades. I saw them bite the glue and then step aside and endeavor to rid their lips and tongues of the objectionably tasting substance. They returned, however, to their task, nor did they cease until they had freed the prisoner and had thoroughly purified her.

This seemed like true, disinterested pity and affection, especially since some of the ants were made sick by the quinine. I am fully aware of the fact that many observers have attributed a certain degree of emotional æstheticism to ants; yet it would be exceedingly difficult to prove that any element of æstheticism enters into the pity, sympathy or affection that these creatures may entertain for one another. Their interests are so entirely communal that individualism (the communal mother and, sometimes, the communal father being excepted) is entirely unknown; hence, any interest evinced by an ant toward another ant must be, necessarily and fundamentally, selfish in its nature. Incidentally it is for the good of the individual, but primarily and principally it is for the good of the colony, inasmuch as each individual is a fraction of the integer, which would be, to a certain extent, marred by the loss of a single ant!

That ants do evince a material interest in one another cannot be disputed; and such is their status in the economy of nature, that it is well for them, perhaps, that this interest is material instead of æsthetic.

On one occasion I disabled a rufous ant by amputating two of her legs. I then placed her near the entrance to her nest. An ant came out and, after examining her critically, took her up and carried her into the nest. Lubbock gives an instance of ants nursing and caring for a sick comrade. McCook, Forel, Huber, Belt, Bates, and many other observers also give instances of ants caring for and assisting wounded or sick comrades; therefore, I think that we may accept it as a fact. Yet Lubbock seems to infer from his bottle experiment that ants do not assist one another when in difficulty. He put some ants in a bottle, over the mouth of which he tied a piece of thin muslin. These imprisoned ants were visited by their friends, yet no effort was made to liberate them.

If a glass wall reached from the equator to the zenith and encircled the entire earth, thus separating the inhabitants of the world, the people on the north side of the wall, I take it, would consider themselves just as free as those who dwelt on the south side of it. The ants, in Lubbock's experiment, reasoned pretty much in the same way. The ants in the bottle did not know that they were imprisoned, nor were the ants on the outside any wiser. The experimenter ignored the physio-psychical limitations of the animals under observation. If, in his experiment, he had made the ants cognizant of the fact that their friends were imprisoned, they would have endeavored to free them; of this I have not the slightest doubt.

The tender and watchful care that is bestowed on the young ants by their foster mothers is exceedingly striking. In fact, were it not for these watchful guardians, the young imagoes would die in infancy, for the young ants cannot emerge from their cocoons unaided; they will die as pseudo-crysalides unless the old ants assist them to come out.

The education of the young takes place in the darkness of the nest, and they are put to work early in life. In point of fact, I have seen the young of rufous ants, only six hours old, busily engaged in caring for pupæ which were about to emerge from their cocoons.

It was my fortunate privilege very recently (May 22) to witness a sight not vouchsafed to many observers. In fact, I can find nowhere recorded a like instance. So it probably stands unique in the history of ants. I was observing a colony of yellow ants (L. flavus) when a dozen or two large-headed individuals came out of the nest and carefully quartered the ground to and fro in its vicinity. They seemed to be a scouting party sent out for the purpose of seeing if there were any enemies in the neighborhood. After they had examined the ground for several feet on all sides of the nest, they came back and stationed themselves about the entrance. In a few moments a large number of young ants came out accompanied by a number of ordinary workers. The large-headed ants formed a circle about the entrance of the nest and kept the young ones from straying away. These latter, apparently, were out for exercise or play, for they raced about, wrestled with one another, and indulged in mimic battles. The

workers walked about among them for all the world like monitors or ushers in charge of a company of school boys. This strange scene lasted for fully two hours; the young ants then gradually went into the nest, followed by the workers; finally the large-headed individuals disappeared and this astounding show came to an end. I called my gardener to witness this unique performance, but I must confess that he disappointed me by saying that he saw "nothing at all wonderful in the affair."

Several observers have stated that they have seen ants at play, but none of them have recorded the fact that they have ever seen young ants engaged in any such performance as I witnessed.

JAMES WEIR, Jr., M.D.

ANIMAL COLONIES AND THE FORMATION OF ORGANISMS.

LAMARCK was the first to assert that, although the origin of life still remains mysterious, scientists should not consider the mystery as impenetrable. Life must have appeared upon the earth under the action of forces that are still acting, but that we do not know how to combine, and the illustrious naturalist endeavored, as far as it was possible in his time, to ascertain how the miracle of such appearance had been performed. Supposing this problem (which we ourselves will doubtless have to relegate to the scientists of the next century) to be solved, and recognizing the fact that there are simple and complicated animals, he was naturally led to ask if the latter did result from an improvement of the former. It seems to him that the organism of living beings must have varied by very reason of the variety of the terrestrial world. Two similar animals, placed in different conditions, must, according to him, have experienced different needs, and, in order to satisfy these, must have used their organs differently. The same organs, left in repose by one and put in activity by the other, must have become atrophied in the first and become developed in the second. At the end of a certain length of time, these animals, primitively alike, must therefore have become different. The variations thus acquired by exercise or disease of the organs must have been transmitted by heredity. Hence the diversity of living forms.

Unfortunately, although Lamarck succeeded in plausibly explaining the modifications of organs that already exist, their adaptation to different uses, or even their disappearance in consequence of their inertia, he was able, as regards the appearance of new organs, to make suppositions only that were so hazardous that they caused his powerful conception to be momentarily forgotten.

Lamarck's theory, being based upon the existence of a sensation, that of need, which in turn brought in the intervention of a faculty essentially animal, that of will, was, moreover, inapplicable to plants. Although it permitted of understanding in a certain measure that the animal organism had been the subject of gradual and continuous modifications, it took no account of one indisputable fact common to the two kingdoms—the existence of species, that is to say, of forms which, even when they are allied, as the dog, wolf and fox, the rabbit and the hare, or our little singing birds, can live side by side without intermixing and without any transition ever being found between them.

It is just this aspect of the question that Darwin examines. Leaving aside the question of the origin of living forms, taking them at any degree of complication whatever, and even abstaining from trying to ascertain under what influences such forms become modified, Darwin borrows his starting point from Lamarck—the heredity of characters acquired during life in any manner whatever. He then shows how, the hereditary variations having been once acquired, the multiplication of similar but not identical living beings in the same region involves a struggle for existence, in consequence of which those beings alone that possess the most advantageous characters under given conditions succeed in living for a long time and in reproducing themselves. Such survival of the fittest has for counterpart the disappearance of the less favored. So the advantageous variations exalt themselves from generation to generation. Every useful variation is soon carried to its maximum of intensity in some individuals, and the latter hence cause the disappearance of all those that come in late behind them. The chain of variation that connected the individuals existing at their starting point is thus broken, and a new species, entirely isolated in appearance, has been created. What Darwin has endeavored thus to explain is therefore indeed, as the title of his book shows, the Origin of the Species. What Lamarck proposed was an entirely different problem, that of the origin of variations in animal forms. The solutions that the two proposed leave out a third problem, that of the formation of organisms and of the causes that have led to their gradual complication.

I have endeavored to broach this third problem in a book that I have published under the title of "The Animal Colonies and the Formation of Organisms." The conditions under which it is proposed are now very plain. All the micrographic studies to which innumerable naturalists have been devoting themselves for more than sixty years past, and that have now attained the utmost precision, lead to the formulation of the following proposition: All living beings easily visible to the naked eye are formed through the agglomeration, in quantities that are often innumerable, of microscopic elements of quite complex but constant structure, differing from each other only in secondary details of form, and which are named indifferently "anatomical elements" or "plastids."

On the contrary, the majority of the microscopic living beings are formed of a single plastid capable of multiplying itself by division, and the plastids that emanate one from another in this way rapidly cease to exhibit any tie between them. These beings formed from a single plastid (Fig. 1) constitute a large group in the animal kingdom, that of the Protozoa, of which the Infusoria are the best known representatives. In the vegetable kingdom they are the simplest of the fungi and algæ. The microbes and bacteria are examples of the latter that have now become familiar.

On another hand, however varied be the phenomena of multiplication in the organisms formed by an association of plastids, in the vegetable as well as in the animal kingdom, the pluricellular organisms always have for a starting point a single plastid, the egg, and the innumerable plastids that concur in the formation of the body of a high organism are all, without exception, derived from the repeated divisions of this primitive plastid.

Since in the present world every individual begins by being reduced to a single plastid, and since there still exist in our day a large number of beings that remain reduced to such state, it is natural to conclude that the first living beings were all unicellular, and that, consequently, the original ancestors of animals entered into the great category of Protozoa. This conclusion will assume considerable force if there still exist series that rise without too abrupt starts from the Protozoa to the most complex forms of the animal kingdom. Further along the question will be proposed whether such forms have been created all at once or

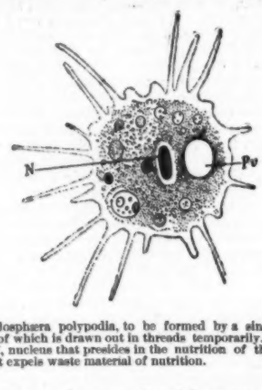


FIG. 1.—Dactylosphæra polypodia, to be formed by a single plastid, the substance of which is drawn out in threads temporarily. (Highly magnified.) N, nucleus that presides in the nutrition of the plastid; Pv, vesicle that expels waste material of nutrition.

whether they have been produced by successive stages, and whether it is not possible to recognize in the realization of such stages the constant exercise of some faculty common to living beings. Such faculty once known, the proximate cause of the complication of organisms would be by that very fact determined, and we should have to endeavor to ascend from this cause to others that are more profound.

Now, an attentive study of the animal kingdom shows that all the pluricellular organisms that compose it allow themselves to be easily grouped in five series:

1. SPONGES (Calcareous sponges and Siliceo-corneous sponges).
2. POLYPS (Hydromedusæ, Siphonophoræ, Acalephs, Ctenophoræ, Corallians).
3. ECHINODERMS (Cystoids, Blastoids, Asteroids, Ophiuroids, Echinoids, Holothuroids, Crinoids).
4. CHITINOPHORÆ (Arthropods: Onychophoræ, Merostomeæ, Arachnida, Pycrogonidæ, Crustacea, Myriapods, Insects; Nemathelminthes: Echinodenidæ, Acanthocephala, Gordiaceidæ, Desmoscolecidæ, Nematoids).
5. NEPHRIDIÆ (Lophostomeæ: Rotifers, Bryozoans, Brachiopods; Worms, Mollusks, Tunicates, Vertebrates).

In each of these series the organisms may be arranged according to an order of increasing complication, from a simple form in which we observe no other repetition of parts than that of the plastids (which, moreover, are apt to group themselves into dissimilar organs) up to diversely complicated forms whose body divides in most cases into parts that are more or less similar, and in which all the organs are repeated. Each of the parts into which the complex forms are decomposed has, moreover, exactly the same structure as the form with which the series begins. It is, therefore, possible to connect all the organic forms comprised in a same series of the animal kingdom by a simple law: The complex forms of a given organic series of the animal kingdom are only an aggregate of parts identical with the simplest form of such series. It is to aggregates of this kind that naturalists have given the name of colonies.

In the presence of this general proposition, we may give a name to the initial form of each series, and we shall call it a merid. We shall designate the complex forms as zooids. A zooid will, therefore, be a sum of merids, just as a merid is a sum of plastids.

In the most complex organisms, the body is not solely divided into merids. We quite often distinguish therein groups of merids that assume a more or less marked individuality and may even separate from the zooid in order to lead an independent existence. Each of these groups must be considered as a zooid. The entire organism is, therefore, either a sum of merids and zooids or a sum of zooids, that is to say, something more complex than a zooid. The organisms thus constituted we shall call demes. A simple law still further connects the zooids and demes in the same series: In each series of the animal kingdom the lowest forms are merids. Afterward come the forms constituted by the repetition of merids all alike, and which are, consequently, zooids. Finally come the forms constituted by a sum of zooids that are in general different from each other, and that, consequently, have the signification of demes.

Thus, the plastids do not seem destined to constitute an organism all at once. Just as men do not form, all at once, great nations that are centralized to such a point as to be but a single body of which all the parts are harmoniously founded, just so the plastids unite feebly in the first place (Fig. 2), and then become aggregated into merids, which afterward become aggregated into zooids, that in turn form demes. Just as the ties that connect the tribes of the same people, and the cities and provinces of the same nation, are in the first place quite lax, but become closer in measure as the relations become easier and the common interests become more numerous, just so the merids and the zooids, which might at first easily separate from each other in order to lead an independent existence, become more and more thoroughly independent and finally become no longer separable.

The instrument of such solidarization is the same in both cases. In human societies, progress is due to the variety of aptitudes combined with individual initiative. Every happy initiative assures advantages to those who have taken it, and of these they have dos less the exclusive benefit for a certain length of ti but their prosperity soon becomes an advantage to family and to the people of which they form p Such initiatives are exercised in different directio by very reason of the variety of the faculties of individuals. It soon results that each assumes a r that is adapted to him in the society of which he for part, and such division of roles between the initiat is what is called a "division of labor." As the labor each is profitable to all, and as each one works accor ing to his aptitudes, if a sufficient initiative is left him, and consequently works better than if a task which he is not fitted is imposed upon him, and every laborer does so much the more perfect work proportion as he devotes himself thereto more exc sively, the division of labor leads to the consequen that a relatively limited number of individuals have charge the production of the objects that are indisp sable to all. From this moment, all the producers b come reciprocally necessary, and a close interdepe ence is established between them. They become the after inseparable from one another, and the society which they belong acquires by that fact all the ch acters of an individuality of a high order. The r that each individual played voluntarily becomes social function.

The function, moreover, impresses upon those w exclusively exercise it special external characters th permit of the recognition, with some precision (by practiced eye, at least), of the soldier, the priest, t magistrate, and the laborer, and, among the labore the corps of trades often have a certain manner whic even in the absence of any special costume, clearly b trays them. The division of labor, while induci solidarity, therefore induces a sort of polymorphism the individuals. The individuals who perform t same function, or similar functions, whence they d rive their origin, necessarily have interests in commo Peculiar ties are established between them and throug their union they form corporations or syndicates th also possess a certain individuality, but a subordina one, since it represents simply a function that wou no longer have a reason to exist if the social body d appeared.

The unity of the social body, its solidarity, is, mor over, reinforced by the advent of real ties that put a its parts in intellectual communication, as do corr spondence, newspapers and books. The organs of thes material ties, by the very fact that they are designe to establish relations between all the parts of the soci organism, are essentially, at the bottom, undivid properties, so that they may be momentarily exploit by private individuals. It is clear that the degree improvement and development of undivided prope ties measures the degree of solidarity of the social bod to which they belong.

All these things are evident, even from a superfici study of human societies. So, some physiologist struck by the resemblances to animal organisms th such societies exhibit, have endeavored to deduce law of political economy, those of the progress of organi tion, while politicians or philosophers, reversing th problem, have sought for comparisons suitable to su tain their conceptions in the history of the progress animal organization. The problem thus reversed evidently alone proposed in a scientific manner. It rightly that Messrs. Espinas, Izoulet and Worms see our human societies the last actual term of an evolutio that has gone on through the entire animal kingdom Hence an exact knowledge of the conditions and law of this evolution assumes a philosophic importance the first order, since such conditions and such laws well understood, determine the place of man in natur and teach him his rights and his duties, not onl with respect to his similars, but also with respect to a that surrounds him, living beings or inanimate objects They are the sole bases upon which, in a society tha asserts itself eminently laical, can be built a genera

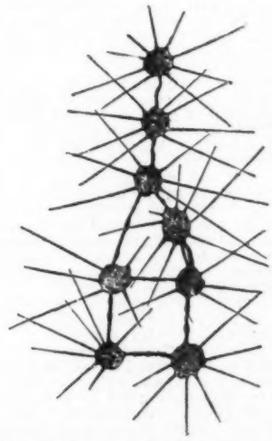


FIG. 2.—Monobia confluens; representing an association of plastids analogous to that of Fig. 1, and united solely by temporary prolongations of their bodies.

morality capable, like evidence, of imposing itself upon the minds of all men, and of soaring (because it results from the force of things) above all dissensions.

The sole fact that living beings are formed of individual units (plastids) shows, moreover, that the parallelism seen by so many fine intellects between organisms and societies belongs not merely to the domain of rhetoric. Men, just like the most humble plastids, are subjected to the triple necessity of feeding themselves, of assuring their individual security and of multiplying. The societies of the one, like those of the other, have no other object than that of being able to provide for this triple necessity by the most appropriate means. From the identity of object result resemblances that are so much the less debatable in proportion as the means employed to this effect are governed by the same conditions in general that form

that we call life. It is therefore useful, by taking a well defined example, to state with precision the successive stages of the organic complication in a determinate series, and we shall select that of the polyps as presenting the clearest phenomena.

Here the initial merid, which it is easy for everyone to observe, and which has been rendered celebrated by Trembley's experiments, is the fresh water hydra. This animal is a sort of cornet fixed by its closed extremity to walls formed of two superposed layers of epithelial cells and with an aperture surrounded by hollow flexible prolongations called tentacles. The best fed hydra does not exceed a centimeter in length. As soon as it has reached this size it, instead of continuing to grow, produces a protuberance at some point or other of its body. This protuberance, which, as in plants, is called a bud, soon becomes a hydra similar to the first. The young hydra detaches itself before long and begins to lead an independent life. This phenomenon occurs during the entire summer; but in the autumn the animal produces eggs, which in the spring give birth to a new hydra.

The hydra, therefore, lives in the state of a merid. However, when abundantly fed and kept at a proper temperature, the hydras that have budded one upon another separate but tardily. Trembley has thus been able to obtain small trees formed of twenty superposed hydras whose digestive cavities all communicated. These hydras, which are apt to separate at the least accident, when they remain united under favorable conditions, constitute but one and the same organism; that is, a zooid. In fact, the majority of the animals allied to the hydras remain in this zooid state permanently (Fig. 3). All the individuals generated

FIG. 3.—Hydractinia echinata. Fragment of a hydrozooid (magnified about fifteen times). a, b, c, nutritive merids diversely expanded; d, tactile merids; e, reproductive merids.

one upon another constitute arborescent zooids, whose form is often definite. To obtain such a result, it suffices that the hydras shall produce a sheath which extends over the buds when they are formed and protects them against accidents and consequently favors the union of all the individuals. The organisms thus formed may be called hydrozooids, and the merids that constitute them may be styled hydromerids.

Since, in a hydrozooid, the digestive cavities of all the hydromerids communicate with each other, it may happen that a portion of the merids suffices for capturing and elaborating the quantity of food necessary for all. The others will therefore be able to do without a mouth. Their non-stimulated digestive faculties will become enfeebled, while their faculties of motion or sensitiveness will become exalted and their form be consequently modified. In fact, in a very large number of hydrozooids (Fig. 3) we distinguish, by their form and very different functions, nutritive merids, prehensile merids, tactile merids, defensive merids, fixing merids, reproductive merids, etc. Social life here, as in human societies, has led to a division of physiological labor, polymorphism and solidarity, since our dissimilar merids can no longer separate from each other without exposing themselves to the danger of dying.

As a general thing, a certain number of merids become modified around reproductive ones in order to form a protecting apparatus for them. One of the most remarkable cases, by reason of its frequency and its consequences, is that in which four prehensile merids form a verticil beneath a reproductive merid, which is provided with a mouth, but the tentacles of which are often abortive. When such prehensile merids are agitated in water by reason of the resistance of the liquid, they draw to themselves simultaneously the region of the internode upon which they are

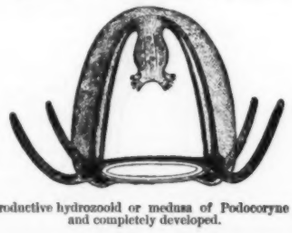


FIG. 4.—Reproductive hydrozooid or medusa of Podocoryne carnea, free and completely developed.

fixed and expand it into a bell that hangs down around the reproductive merid. Naturally, this bell carries by its free edge the four prehensile merids. It is contractile, and every time that it closes it drives the amassed water into its concavity. The expulsion of this water brings about a movement of recoil of the bottom of the bell, the peduncle of which, pulled by these abrupt motions, finally breaks. The bouquet of five hydromerids thus set at liberty possesses all that is requisite to allow it to live in an independent manner—a mouth, a stomach, a locomotive apparatus, merids serving as organs of prehension, and reproductive organs even. This bouquet thereafter becomes an autonomous organism. It is what is called a medusa (Fig. 4). A medusa is a hydrozooid. Every association of hydromerids upon which one of them forms, comprising, therefore, merids and zooids, will, in a general

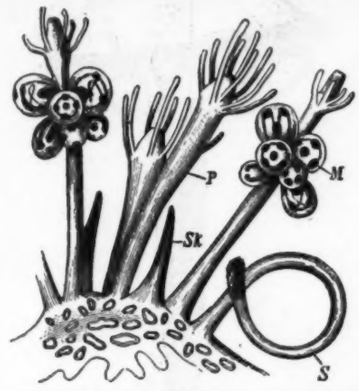


FIG. 5.—Fragment of a hydrodeme of Podocoryne carnea, formed of nutritive hydromerids, P, tactile hydromerids, S, defensive hydromerids, Sk, and reproductive hydrozooids, or medusæ, M (Magnified about fifteen times.)

manner, be a deme, and in the species, a hydrodeme (Fig. 5).

Some singular hydrodemes, instead of fixing themselves to the ground, as usually happens, attach themselves to a bubble of air and then constitute floating hydrodemes. In such hydrodemes, a certain number of medusæ cease to serve for reproduction and operate as locomotive organs, which work in concert to assure the displacement of the hydrodeme. The hydrodemes thus formed exhibit, with a definite shape for each species, a very great variety of structure. They constitute an entire class of hydro-medusæ, that of the Siphonophoræ (Fig. 6).

The hydromerids exhibit still another mode of grouping, which ends in the formation of a radiating organism called coralizoid, the type of which is the sea anemone (Fig. 7). These coralizoids are ordinarily grouped into coralliodemes, and constitute a class of polyps also, that of the Corallians.

FIG. 6.—Siphonophora or floating hydrodeme. (Cupulita tergestina.) Pn, float containing a bubble of air; S, locomotive medusæ; P, nutritive merids; D, protective merids; Nk, prehensile merids.

The medusa is the reproductive form of the primitive hydrodemes. It grows upon the hydrozooid like a flower upon a plant. It happens in an entire series of polyps that the hydrozooid assumes less and less importance. The egg appears to hasten toward the production of the medusa, which it ends by directly forming. This haste of the egg toward the formation of a complicated organism, and which is observed, too, in the Siphonophoræ, is a phenomenon found in the entire animal kingdom. It is the phenomenon of embryonic acceleration or tachygenesis. Its importance is such that comparative embryogeny is, at the bottom, only a study of its laws. The medusæ of direct development form the class of Acalephs, whence appears to be derived that of the Ctenophoræ.

The ties that connect the organisms of the series of polyps therefore appear here of extreme simplicity. The limitation of the size of the merids, the germination or budding, the association of the merids due to budding of one upon another, their differentiation, the division of labor among them, and the solidarization of certain merids announce the advent of the merids

FIG. 7.—Sagartia nivea. A corallizooid formed by hydromerids arranged in radii.

and consequently the transformation of the hydrozooid into a hydrodeme; the solidarization of all the parts of the hydrodeme announces the formation of the Siphonophoræ; and finally, embryonic acceleration leads step by step to the direct production of a hydrozooid by the egg. Such are the stages traversed. It would be easy to show entirely analogous ones in the series of Sponges or in that of the Echinoderms.

In these three series, the merid, having made its exit from the egg, which for this reason may be called the oomerid, fixes itself. Let us now suppose an oomerid free, as are all those that are notably heavier than water. In this case, it will not be able to raise itself erect and wait with open mouth for food to be brought to it by the surrounding water, and yet the budding will not disappear on that account, but will take place under very peculiar conditions.

Submitted to the necessity of searching for food, such a merid will be led to move in carrying to the front the extremity of the body in which its mouth is situated. Therefore, every bud that appears elsewhere than at the posterior extremity of the body will be applied against the walls of the latter during locomotion and be led to fasten itself thereto. The merid will therefore bud only at this posterior extremity, and the zooid resulting from such budding will necessarily be an organism formed of segments placed end to end—a segmented organism, such as an insect (Fig. 8), an earth-

FIG. 8.—Campodea staphylinus. A primitive insect with a body formed of a succession of metamerids.

worm or a leech. It is for the animals thus formed that Cuvier created the branch of Articulates. But all recent researches have shown that the segmentation of the body is not a character peculiar to Cuvier's articulated animals. We see, in fact, segmentation gradually becoming effaced, under the influence of parasitism, in the arthropods that pass by sparing transitions to the Nematoids, the type of which is the Ascaris lumbricoides, or intestinal worm so often passed by children. Under the same influence of parasitism, segmentation is gradually effaced, too, in the annelid worms, which thus pass to the flat ones.

Despite the apparent unity of their bodies, the mollusks themselves, such as snails and oysters, exhibit in the course of their development very plain traces of segmentation. As for the segmentation of the bodies of the vertebrates, that had already been recognized by Geoffroy Saint Hiliare, merely through a study of the skeleton, the vertebræ and ribs of which are repeated with so much regularity, and it was put out of all manner of doubt by the labors of Balfour, Semper, Sprengel and others upon the structure of the renal apparatus of these animals. So all animals whose body is not ramified by budding, and which get beyond the state of merid, have a segmented body or one derived from animals whose body was segmented. They have been produced by the same mechanism as the ramified animals—by budding; only such budding, instead of being exercised in an irregular manner, as in the fixed merids, has been rendered regular by the exercise of locomotion, the faculty of which has been preserved by the heavy merids.

Embryogeny demonstrates that the merids that are the progenitors of segmented organisms are very likely rotifers (Fig. 9). The lower annelid worms are pro-

duced, in fact, under what is called the "trochosphere form" (Fig. 9), which is represented almost exactly by a rotifer of the Philippines, the Trochosphæra æquatorialis (Fig. 10), and it is also under this form that are produced the majority of the mollusks. So, too, the lower Crustaceans are all produced under what is called the "nauplius form" (Fig. 10), which is also nearly recalled by certain other rotifers—the Pedalions (Fig. 11).

The worms, mollusks and vertebrates probably descended from normal rotifers, and the arthropods and nemathelminthes, according to the recent researches

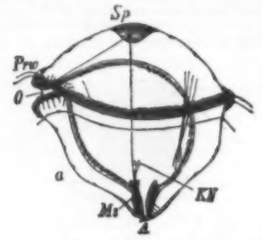


FIG. 9.—Trochosphere. A larval form common to the annelid worms and mollusks. (Highly magnified.) Sp, nervous plate; Prw, band of vibratile cilia used for locomotion; O, mouth; KN, kidneys; Ms, first rudiments of the internal tissues; A, posterior orifice of the digestive tube.

of De Zograf, from rotifers that have become cuirassed with chitine.

Starting from this conception, the entire history of the segmented organisms is of remarkable clearness, and is closely connected with that of the ramified organisms.

Two conditions of existence of the merids, which are themselves connected with the relative weight of such organisms, explain that in the polymerid animals there were two types of structure, and two only, and that one of these closely recalls the type of structure of plants, which, like them, are fixed. The same theory, therefore, embraces the history of the organic complication in the vegetable as well as in the animal kingdom. Such a result, obtained not by a simple effort of the imagination, but by the strictly scientific grouping of indubitable facts worthy of our attention, since it [illegible] to the investigation of [illegible] anatomy and embryogeny a precise method. It furnishes an explanation of the partial laws previously expressed, shows their raison d'etre, determines reciprocal relations, and, finally, closely connects biology with sociology, which is merely the terminal stadium thereof.

Nevertheless, an endeavor has been made in recent times to give explanations of the segmentation of the body of symmetrical animals that would put it outside

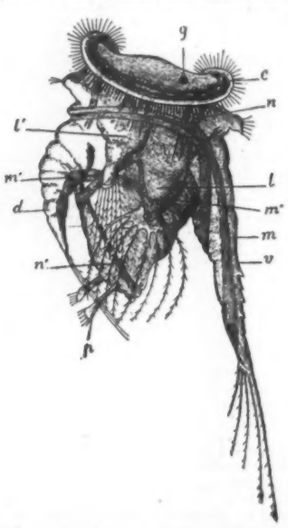


FIG. 11.—Pedallon mirum. A nearly microscopic rotifer, closely resembling a nauplius (side view). g, eyes; c, ciliated ring; m, m', m'', n, n'', muscles; dv, odd limbs; l, l', even limbs analogous to those of nauplius; p, tactile organs.

of the general conception that we have just developed. One has wished to see therein the consequence of the undulations of the body of an annelid worm about to swim—undulations that would have broken in a regular manner either the muscular fibers or the genital organs primitively arranged in the interior of the body in two solid columns.

FIG. 12.—Trochosphere of the same species that is shown in Fig. 9, and which has already produced a large portion of the body of an adult annelid worm. The segments are so much the younger and consequently so much the less developed in proportion as the posterior extremity of the body is approached.

An endeavor likewise has been made to explain this remarkable and general division of the body into successive segments by admitting that, in order to increase

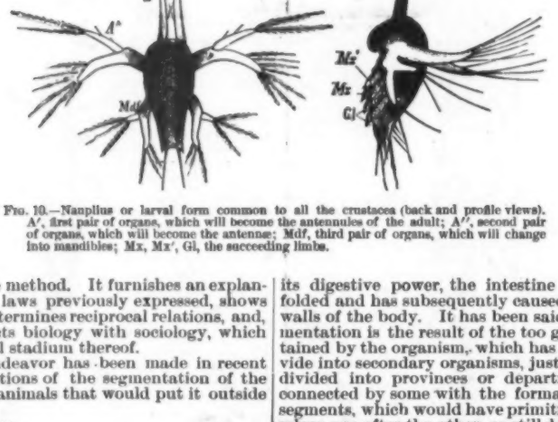


FIG. 10.—Nauplius or larval form common to all the crustacea (back and profile views). A', first pair of organs, which will become the antennules of the adult; A'', second pair of organs, which will become the antennæ; Mdf, third pair of organs, which will change into mandibles; Mx, Mx', Gl, the succeeding limbs.

its digestive power, the intestine has been regularly folded and has subsequently caused the folding of the walls of the body. It has been said, too, that the segmentation is the result of the too great dimensions attained by the organism, which has been obliged to divide into secondary organisms, just as a large country is divided into provinces or departments. It has been connected by some with the formation of the genital segments, which would have primitively detached themselves one after the other, as still do those of the Tænias or tapeworms. In the first hypothesis all the segments

FIG. 13.—An Autolytus that has produced a head toward the middle of its body, and is upon the point of dividing into two.

of the body must have formed simultaneously in the adult animal. On the contrary, they form successively and only in the young, as shown in Fig. 12. The second hypothesis could be applied neither to the arthropods nor to the worms, whose digestive tube remains nearly straight, save in a few very modified forms. Now the segmentation of the vertebrates is manifestly of the same nature as that of the annelid worms, and it is not necessary to invent a particular explanation for it. Before this second hypothesis, moreover, rises the same objection as before the third, to wit, that, according to both, the segmentation must have been special

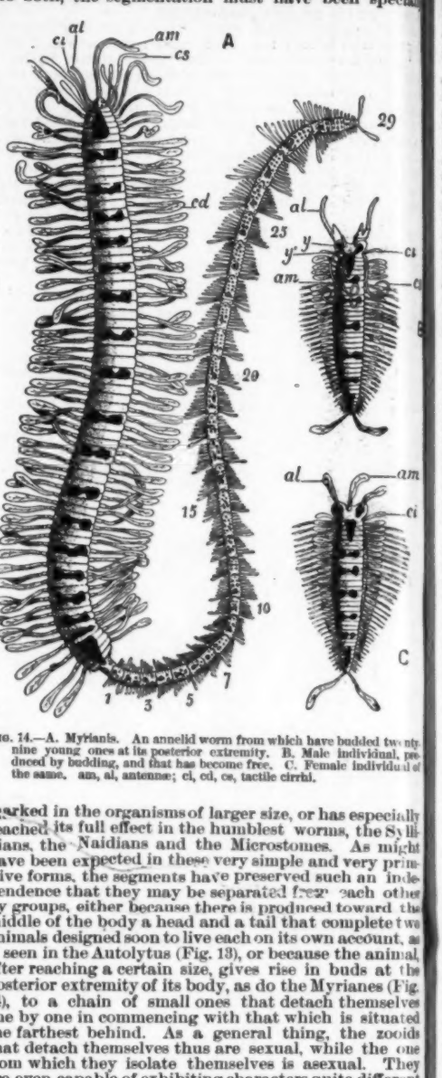


FIG. 14.—A. Myrianis. An annelid worm from which have budded twenty-nine young ones at its posterior extremity. B. Male individual, produced by budding, and that has become free. C. Female individual of the same. am, al, antennæ; ci, cd, cs, tactile cirrhi.

marked in the organisms of larger size, or has especially reached its full effect in the humblest worms, the Syllidians, the Naidians and the Microstomes. As might have been expected in these very simple and very primitive forms, the segments have preserved such an independence that they may be separated from each other by groups, either because there is produced toward the middle of the body a head and a tail that complete two animals designed soon to live each on its own account, as is seen in the Autolytus (Fig. 13), or because the animal, after reaching a certain size, gives rise in buds at the posterior extremity of its body, as do the Myrianes (Fig. 14), to a chain of small ones that detach themselves one by one in commencing with that which is situated the farthest behind. As a general thing, the zooids that detach themselves thus are sexual, while the one from which they isolate themselves is asexual. They are even capable of exhibiting characters quite different from those of their parent. They are, consequently, reproductive zooids comparable to the medusæ, from which they differ especially in the arrangement of the parts, which are verticillate in the medusæ and placed

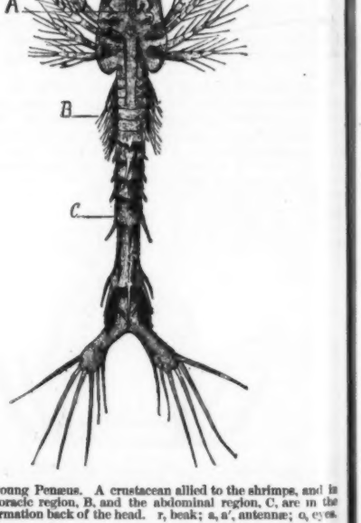


FIG. 15.—Very young Penæus. A crustacean allied to the shrimps, and in which the thoracic region, B, and the abdominal region, C, are in the process of formation back of the head. r, beak; a, a', antennæ; o, eyes.

end to end in the annelid worms. Finally, the fourth hypothesis differs from our general theory only by the very useless introduction of the function of reproduction into the appearance of budding.

The explanation of the metameridiation that results from what is calle.. the theory of animal colonies presents none of these difficulties. Moreover, if it is the

simplest worms that are the most distinctly segmented, if, when the segmentation is merely temporary, it is always in embryos that it shows itself, and if in every series of the animal kingdom it is always the lower forms that are produced in the state of merids, that implies that the metameridiation is the very mechanism of the formation of the body, and not a method of improvement of a body already formed.

A segmented animal is therefore a linear colony of merids, as Durand de Gros perceived as long ago as 1861 and Dugas as long ago as 1832. In such a colony the same phenomena are exhibited only in a hydrodeme. Polymorphism and the division of physiological labor lead in the first place to the formation of a sensitive and buccal region—the head. We have often seen the appearance of a reproductive region which is capable of isolating itself, as in the medusæ, and exhibits characters that are quite peculiar. In most cases, however, things do not go so far as this. Back of the head there forms simply a locomotive region or thorax, a visceral region or abdomen (Fig. 15), and more rarely an atrophied region or tail. These regions often possess a certain physiological autonomy. From this point of view they may be considered as zooids, and consequently the upper metamerid organisms have the rank of demes.

The linear arrangement singularly facilitates in such demes the grouping of the similar parts of the merids in these sorts of syndicates or corporations, which are the tissues, the organs and the apparatus. The material relations are established by a circulatory system, and the relations of co-ordination by a nervous system, an undivided property among all the merids, and the unity of which completely assures the solidarity of all the parts. In the highest vertebrates there is even produced an extreme centralization, which they pay for by a fragility that is relatively greater than that of the lower vertebrates.

This centralization in the vertebrates does not prevent the constituent merids of the body from remaining clearly distinct, as is shown by the entire organization of the lower vertebrates and the method of development of the higher ones. There are, on the contrary, cases in which certain conditions of existence (parasitism, fixation to the ground, habitation in the interior of a shell or hole, etc.) may lead to the fusion of all the merids into a single undivided body. The Gephyrians, the flat worms, the Arachnids and the parasite Crustacea show us all the phases of such fusion, which is almost entirely realized in the Nematoids and Mollusks.

On another hand, owing to tachygenesis, favored by the accumulation of a larger or smaller quantity of nutritive material in the egg, the precocious birth and the slow development, merid by merid, of the lower forms are replaced by so rapid a development that all the pieces of the organism seem to form almost instantaneously, and that the latter leaves the egg with its definite form, having nothing further to do but to grow.

Here, then, we are in possession of a mechanism owing to which all the successive stages of the organic complication may be easily chained one to the other. Were the first organisms simple plastids, as are now all individuals at the beginning? There is no reason why the same mechanism should not have been applied to the gradual formation of organisms in the course of time gone by, and be applied to the present formation of individuals. There exist, then, necessary ties between paleontology and the comparative morphology of the present forms and their embryogeny.

If there still exists any doubt as to the first causes of budding, there is no doubt about the fact itself, and it suffices to establish the proposition that the victory of organisms in the struggle for existence has been obtained by association. The associations have been gradually fortified by reciprocal sacrifices that have been made by individuals, without, however, ever abandoning their personality, save in a few degraded types. Discipline, the constitution of common organs and that of social reserves, accompanied always with personal reserves often transmitted hereditarily, have been the most active factors of improvement. Upon the whole, it is therefore the practice of what we call social virtues that has made organisms powerful and assures their duration. It would be easy to establish the fact that, when once the form of the body was realized, force began constantly to succumb to intelligence. It was by the great development of their nervous system that the vertebrates first characterized themselves, and in this respect they did not cease to progress until human reason finally dominated the organic world. The doctrine of evolution, then, does not, as might be thought by superficial readers of Darwin, afford any support to those who believe in the exclusive triumph of material power, and who have got into the habit of glorifying self, in excusing themselves on the plea of the necessities of the struggle for existence. The history of the living world, on the contrary, shows us intelligence everywhere triumphant, and association (that is to say, the constant sacrifice of a portion of one's personality) as the essential condition of progress, even in material well-being. This history teaches us solidarity before all things, and no lesson could be more consoling at an epoch in which so many minds have closed themselves to other light.—Edmond Perrier, in La Revue Larousse.

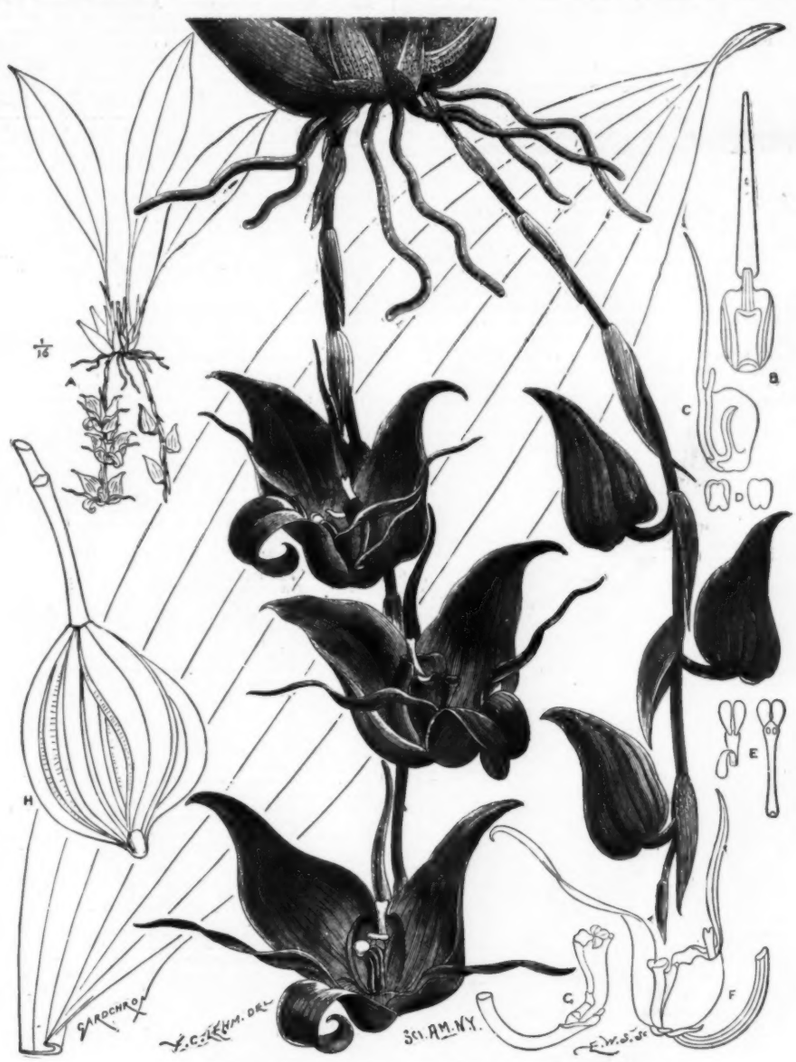
VITALITY OF SEEDS.

"M. C. DE CANDOLLE, says Cosmos, "in presenting some considerations to the British Association relating to his experiments on the vitality of seeds, cited several curious facts that it may be interesting to mention. Thus he related the fact observed in Greece, where, after removing the refuse of a silver mine that had been long unworked, the workmen saw a whole flora appear, evidently from seeds that had been buried under the debris and that must have been so buried not less than 1,500 years. One of M. De Candolle's hearers, an Irish farmer, then mentioned an analogous fact: he had noticed that certain fields that had been uncultivated from time immemorial became covered, as soon as they were tilled, with the wild poppy. It would be interesting to know whether the poppy had not been growing near by; the fact would not be comparable with that related by M. De Candolle unless no poppies were to be found in the vicinity. Another auditor, Mr. Seward, a distinguished paleobotanist, says the Literary Digest, remarked that facts of the same kind may have taken place long ago; he thought, in fact, that seeds covered by the glaciers of the ice age may have preserved their vitality and may have germinated centuries later after the retreat of the glaciers."

TREVORIA CHLORIS.

THIS is the second of a number of new genera of orchids which I have discovered during the twenty-one years of my travels in the Andes. Both Trevoria and my Gorgoglossum are old acquaintances of mine; but owing to their great rarity, and their growth in habitats very difficult to reach, insufficient floral material have made it hitherto impossible to publish them.

Gorgoglossum Reichenbachianum, Lehmann (MS., 1879), was met with in December, 1879, in one single specimen on the Western Andes of Ecuador, at an elevation of 300 to 600 meters above sea level. The single specimen was duly given to the late Professor Reichenbach; but the flowers having lost their pollinia, he did not venture to describe the plant, and it wandered with some 3,000 other numbers of the herbaria for twenty-five years to the grave at Vienna. Some eleven years later, when I knew already the fate of my unique Gorgoglossum, I undertook an especial journey to the locality in order to secure a few plants for cultivation in one of my estates in the Cauca. Only five plants were found, of which to-day one exists in my possession and another in that of Sir Trevor Lawrence, the rest having been lost on the sea voyage.



TREVORIA CHLORIS—FLOWERS GREEN.

A, plant reduced to show habit; B, C, lobes of the lip; D, anther caps; E, pollinia and caudicle; F, lip detached (seen from the side); G, clinandrium; H, capsule.

My first acquaintance with Trevoria occurred in 1887. Only three specimens were seen, bearing thin, drooping spikes, about 40 cm. long, of thickly-set seed vessels, but no flowers. The plants I tried to take to the Cauca for cultivation, but, alas! they were stolen from me by some rascal at Esmeraldas during my absence from the steamer, together with a number of other botanical treasures. Nothing more was seen or heard of this plant, which, by the by, looked quite novel and interesting until last year, when during an exploration of a certain portion of the Western Andes of Colombia, with a view of projecting a map on behalf of the Cauca government, a few plants of this species of orchid were observed. The species found in Colombia is, however, quite distinct from that of Ecuador. The latter grows at an elevation of 500 meters above the sea, and produces flower spikes of from twenty to thirty flowers, the size and character being as yet unknown, while the Colombian one inhabits a region from 1,500 to 1,700 meters above the sea (as far as observed), and bears racemes of only three to five, commonly only three flowers.

As a genus, Trevoria is very characteristic and distinct. Its nearest neighbors are Coryanthes, Schlimia, Stanhopea, and Gorgoglossum, but it is distinguishable at first sight from either of them. Trevoria chloris produces large fleshy wholly green flowers, placed on the drooping spike in the manner of the buckets on a dredger chain. The narrow disk of the lip and the thick coriaceous process at its base are the only different colored organs in the flower; they are pure white. Both from a morphological and also from a physiological point of view this genus is very novel and interesting. The position of the column and lip, standing straight upright in an urceolate manner, the thick fleshy process at the base of the lip being of exactly the same length as the column, and standing parallel and closely adpressed to that organ, the peculiar shape and insertion of the stigma and several other items are wholly novel, and the arrangement of them to each other may set at naught some of the pet views of modern hypercritical speculators with respect to the aid of insects in the fertilization of orchids, or give rise to quite new conceptions.

I have named this genus of Orchidaceæ in honor and commemoration of Sir Trevor Lawrence, one of the most enthusiastic orchidists that ever lived. Trevoria has to answer our purpose; Lawrencia and Lawrencella being already in existence in Compositæ and Malvaceæ respectively. May Sir Trevor's love of orchids perdure sempervirent as Chloris the goddess of flowers. Popayan, February, 1897. F. C. Lehmann.—The Gardeners' Chronicle.

AMERICAN TEA CULTURE.

SECRETARY OF AGRICULTURE WILSON has received a report from a veteran horticulturist whom he sent recently to investigate the tea farming industry carried on at Summerville, S. C., with a view to ascertaining the prospects of profitable growth of the tea plant in this country, should it be decided to introduce it here as an industry.

The report says the labor question is the most important one in the economics of this business in this country. It estimates the minimum cost about eight times as much to pick one pound of tea in South Carolina as that paid for the same service in Asia. The report suggests that it seems impracticable to compete with the cheap Oriental labor, and while some of the processes of development have been delegated to machinery, the picking of the leaves, requiring discrimination in selection, has to be done by hand. The problem has been ingeniously met in this Southern field by establishing a small colored school where tea picking is included in the curriculum, and the young scholars, after some instruction, prove good pickers.

As to the future of tea culture in the United States and the encouragement for its extension, the report

quotes the promoter of the South Carolina tea fields as saying that if he were twenty years younger, he would plant 500 acres as rapidly as he could procure the plants, thus indicating his faith in tea raising as a profitable industry. The report urges the development of knowledge as to tea raising by means of schools of instruction.

LIFE ON THE PLANETS.

By M. J. JANSSEN.*

(HAVING shown how all astronomical discovery, concluding with spectrum analysis, points to a similarity of constitution in the earth and the heavenly bodies, M. Janssen continues:)

All this whole forms a single family, the members of which have a common genesis and have been formed with the destiny of becoming worlds like ours. Their movements around the central star which enchains them by its powerful attraction are subject to the same laws, and that star, by virtue of its high temperature and the immense reserves of force it contains, sheds upon them those influences and radiations which go to place upon their surface the generative elements of life. Yet while these stars present so strict analogies in formation and nature, they do not by any means indicate the same degree of advancement in what may be called geological or rather planetary evolution, or that which tends to the appearance and development of life on their surface. Here the conditions of mass, of distance from the sun, and doubtless other circumstances still unknown, come in to order the epoch and extent of these developments; but we can affirm, without going beyond the inductions permitted by the condition of science, that if life has not yet been established directly on the surface of any of the planets, we have very strong reasons for assuming its existence on some of them. We may regard this conclusion as gained from the long labors of antiquity and modern discoveries.

We say that, while the problem has not been directly resolved by the eyes, it has been worked out by an aggregate of facts, analogies, and rigorous deductions that leave no room for doubt. This is the mature and perfect fruit of science. It is the view of intelligence, as certain an authority and of even a higher and nobler order than the senses. I say further that what we know of the unity of the chemical composition of the matter of the sun, the stars, and the nebulæ permits us to make new inductions respecting the part performed by the bodies which are on the earth the most important factors of the phenomena of life. It is thus infinitely probable that hydrogen, oxygen, nitrogen, carbon, and especially water, which on the earth are the indispensable constituents of vegetable and animal life, fill a like office not only in the planets of our system, but throughout the universe.

Water in particular, by virtue of its chemical functions and the properties with which it is endowed in the solid, liquid, and gaseous states—properties which are so admirably fit for the accomplishment of physiological processes—is a unique substance, and the search through the whole series of chemical compounds for any body that can take its place has been in vain. The discovery of the spectrum of the vapor of water permits us to deduce and assert its presence in the atmospheres of the planets and in those of a whole class of stars as well. Drawing from these results the fact of the presence of hydrogen, one of the generative gases of water, in nearly all the stars, we are justified in supposing an extreme diffusion of that important element from the point of the unity of the phenomena which control the production and maintenance of life.

Thus, the more science advances, the more is that great law confirmed and established of unity in the material elements, in the compounds formed of those elements, and in the constitution of the stars and the parts they perform in the grand whole.

Are we authorized now to assume from this a unity of forms that life may put on not only in the sister planets to ours, but also in the other systems of worlds scattered through the skies? May we especially push our inductions still further and higher, conclude from such material unity upon a mental and moral unity, and say that, as there is only one physics and one chemistry in the universe, there are also only one logic, one geometry, and one moral, and that the beautiful, the good, and the true are identical and of the universal order everywhere?

Science, embracing in its results only immediate and demonstrated facts, does not warrant us going so far as this, but with the truths it unfolds to us seems to invite us toward it.

There were brilliant minds in antiquity, which, upon bases otherwise restricted, conceived and proclaimed verities concerning the world and the universe which the most modern science has only been able to confirm.

Let us, then, respect these cheerful speculations. If they are still only of things preconceived, who can affirm that science will not make them real to us tomorrow? By establishing the laws and harmonies of the material world, astronomy prepares us for the conquest of truths of a still higher order.

We can say then plainly that the subjection of natural forces and the reign of man over Nature are only the first fruits of science. It prepares other fruits for its votary of a higher and more precious order. By the beauty of the studies to which it invites him, by the grandeur of the horizons which it opens to him, and the sublimity of the spectacle it gives him of the laws and harmonies of the universe, it promises to win him away from his present preoccupations, which are perhaps too exclusively positive, and will restore to him under a new form and in an incomparable grandeur that taste for elevated poetry, that enthusiasm for the beautiful, and that reverence for the ideal which are among the most imperious needs of the human soul and which it never abandons without peril.

The English war office authorities are a good deal troubled over the results of using cordite for artillery. At a recent practice at Okehampton, out of eighteen guns of the Horse Artillery using cordite in place of ordinary powder, seven guns became useless after firing only two rounds each.

* From his remarks at the annual meeting of the French Academy of Sciences, October 24, 1896.—Translation from the Revue Scientifique by Popular Science Monthly.

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